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Also

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Building Embankment for Head Race and Navigation Canal on Shannon River Power Project

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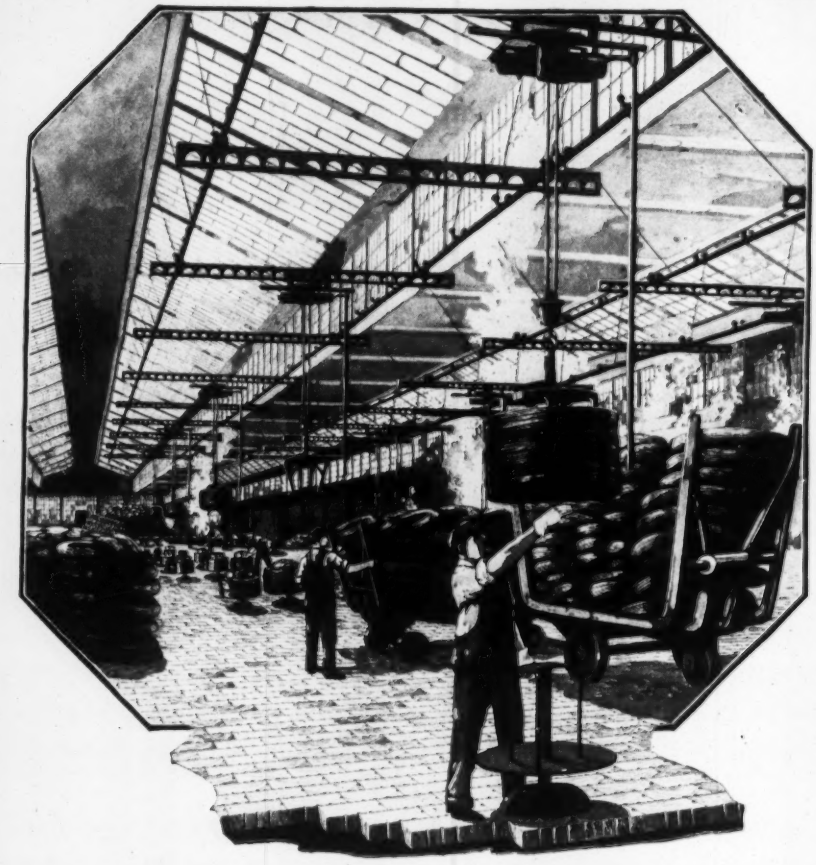

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Editor

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At the Quarter's End

EXAMINATION of the statistics collected by this journal for the first quarter of 1927 shows that so far as construction is concerned this year is traveling on an even keel and that the let-down that some feared has not developed. In spite of the impressions to the contrary given by those statistical bureaus that report only part of the country and specialize in small and residential construction, the most striking fact of *Engineering News-Record's* contract statistics, which cover heavy construction volume, is the almost identical trend of 1926 and 1927. The total is $630,000,000 for 13 weeks this year against $601,000,000 for 12 weeks last year. This practical equality holds for most of the classes of work, as shown by the following figures for 1927 and 1926, respectively: Water-Works, $17,000,000 and $15,000,000; sewers, $20,000,000 and $19,000,000; bridges, $13,000,000 and $14,000,000; roads, $66,000,000 and $62,000,000; public buildings, $49,000,000 and $43,000,000; federal government, $10,000,000 and $10,000,000. Even the volume of large commercial buildings—which include the speculative ventures that were recently put under fire—is 18 per cent above that for the first quarter of 1926. The only important decrease was in industrial buildings—$56,000,000 against $104,000,000 in 1926. The cost situation, meanwhile, far from developing any crises improved even under the heavy demand for materials and labor. At the beginning of the year the *Engineering News-Record* Construction Cost Index Number was 2 per cent higher than a year ago; it is now only one-half per cent higher. It need hardly be said that the decline is attributable to lower materials prices. Labor has evacuated none of its trenches. The significant fact in all of these figures is that the record of the year so far confirms the judgment of those who could see no basic reason for changed economic conditions nor for a pronounced let-down in construction operations and confounds those who felt that because every good thing must sometime cease now was the time for the cessation of the high degree of construction the last few years have experienced.

Cuba's Great Highway

APPRAISED by any standard, the 700-mile paved road being built by the Cuban national government as described in this issue is a remarkable undertaking. Greater mileages of pavement, of course, are contracted for and built every year in some American states, but no single road contract of equal size has ever been awarded previously. The Cuban construction program, however, is not for a year, but for five years. Assuming that the full contract period is consumed in the construction, the average annual expenditure involved will be upward of $15,000,000. But this is a considerable sum for a country of no greater population than Cuba, and so wild and uninhabited as Cuba is for many miles traversed by the new highway. This, it is further to be noted, runs along the backbone of the island virtually paralleling and not at great distance from railways which have nearly the same termini and enter nearly the same centers of population between termini. Except the railways and the new highway, when it is built, there are in many of the provinces no ways of travel better than cart roads, and no traffic which calls pressingly for better ways. Under the conditions the Cubans compel admiration for their boldness in undertaking the cost and the technical responsibilities of the central highway.

Storage or Flood Control

CRITICISM of the plans of the Los Angeles County Flood Control District has been mainly directed toward the overall conception of the project, and not toward the structural execution of its several parts. This criticism is confirmed by the board of consulting engineers whose report is abstracted in this issue. The Forks site for the big San Gabriel dam, the site selected by the Flood Control District, is endorsed in preference to the Granite Dike site urged by the city of Pasadena and by a number of the engineer critics of the official plan, but that is about all the consulting board does endorse. It recommends a storage reservoir there of 180,000 acre-ft. instead of the projected 240,000 acre-ft., and recommends a dam 45 ft. lower than the 430-ft. record-breaking dam proposed; it insists on a dam design which will make conservation subordinate to flood control instead of the reverse as provided by the official plan, and it specifically condemns the engineering detail and economic justification of most of the other structures which had been planned or built as a part of the whole flood-control project. The board's report makes clear that the engineering direction of the project has been concerned not so much with a balanced control of the distributed rainfall that might menace the county when collected in its water courses as with the necessity or desirability of collecting in reservoirs for future use as much of that rainfall as possible. Water is the great necessity in the Southwest, so this desire for its conservation is explainable, but, as the consulting board points out, it is a difficult and complicated problem both to conserve water and to prevent floods. To that problem the most serious engineering effort must be directed, and the conclusion from the history of this project as confirmed by this latest report is that this effort has fallen short of that which is necessary for so elaborate a scheme. That the county authorities have at least realized this is evident from the fact that they have reorganized the engineering direction of the district. It now remains to be seen whether the former chief engineer, J. W. Reagan, who has dominated the plan up to now, will be willing to work with the other engineers on the new consulting board.

Right Kind of Standardization

ONE of the dangers of standardization is that a dead hand will thereby be laid on progress. Some such criticism also lies against the simplification program that has been carried on under the auspices of the Bureau of Standards for the past few years. The answer to such criticism so far as simplification is concerned is found in the readiness of those who promulgate simplified forms and styles to accommodate themselves to the progress of the art, and to recognize that while a part of their function is to restrain unnecessary individualism an equal part is to recognize popular demand. The committee which has in charge the simplication of paving brick has just recognized the latter part of this dual obligation by including in its sizes the thin paving brick. This type was ruled out in the first simplification list adopted some years ago but the growing demand for a thin brick has been quite marked, so much so that it is obvious that for certain uses it serves the field as no other brick size does. The committee therefore at its meeting last week instead of trying to force practice accomodated its rulings to practice. Its standardized sizes still bar a number of out sizes that individual peculiarities might demand—for no good reason other than individual desire—and in that measure serve the manufacturer, who is strengthened in his refusal to humor the individual. But the continued increase in the use of the thin brick, backed up by the recent Bureau of Public Roads tests which showed its excellent qualities, takes that type out of the idiosyncratic class. Flexible standardization may sound like a contradiction in terms, but it describes the proper kind of standardization represented by "simplified practice" rightly administered.

For Better Highway Administration

REBUKING the state highway commission somewhat mildly, a special committee of the Wisconsin legislature which investigated the recent upset of the state's highway engineering staff emphasizes the error committed by the commission in abruptly dismissing its chief engineer without a hearing, as discussed in these pages Feb. 10, 1927, p. 224. The committee finds first that there is no evidence of improper efforts to control the commission or department by any material or process company, so that that phase of the difficulty may be dismissed. It does find, though, that the charges on which the commission professed to base its action were "frivolous and insufficient." This feature of the verdict makes the entire case even more significant than before, both to Wisconsin and to highway administration in general. It is bound to deprive the commission of that support by public confidence without which its labors in directing the expenditure of some $20,000,000 per year cannot remain fruitful.

The investigating committee therefore properly advises a change in the organization of the commission. Heretofore the commission has consisted of two *ex-officio* members—the state geologist and the engineering head of the state university—and three appointive members, the latter "compensated" by a small *per diem* fee. To replace this organization a full-time commission of adequately paid members is proposed, in order that the state's highway construction may be managed actively and continuously. The proposal appears constructive.

No doubt the form of organization prevailing hitherto was built around the idea of minimizing the risk of political control of highway work and assuring a large proportion of scientific and technical knowledge in the membership. In itself this is an excellent idea, but it is subject to the test of practice. It was successful in its practical working during the early years of highway construction. Perhaps it might have remained successful even with operations at their present magnitude provided the commission (the virtual board of directors of the enterprise) could have maintained the authority and soundness of its executive organization and also had held the confidence of the people, to whom in the last analysis the commission is responsible. But in these two points the system broke down. Its failure is made even more pronounced by the error in naming materials salesmen to leading positions in the organization. A commissioner who receives only a nominal per diem for his service, and must depend on outside interests for his livelihood, may not find it easy to avoid serving two masters whose interests are opposed. Under such conditions, the whole situation evidently becomes untenable, and the establishment of a straight business management, freed from outside influence by full responsibility and adequate compensation, is to be desired.

For the present the proposed reform is only a committee recommendation. It is to be hoped, however, that the legislature will accept the recommendation and carry it into effect, in order that the state's excellent record in its highway work may be maintained.

Joints in Ocean Outfall Sewers

THE successful contruction of a large sewer outfall into the open sea is a different matter from the construction of the same pipe in trench on shore. In the latter pipe the pressure is from one direction only, and hence small leaks tend to seal themselves. The surging of the surf over the ocean outfall, on the other hand, produces incessant pressure variations and continual sweep and scour of changing currents around the outside of the pipe. Under such conditions, if a joint does begin to leak the surgings accentuate the leakage, and if it should be in the lower half of the perimeter, undermining and settling may result.

Problems connected with ocean outfalls are receiving much attention in southern California just now because of several such projects under way there. At Santa Ana a 42-in. outfall is being built 2,700 ft. into the sea to replace one laid only a few years ago; the 42-in. ocean outfall laid last year at Santa Barbara is reported to be giving joint trouble, and a $200,000 joint-reinforcing job on the new 84-in. Hyperion outfall of the city of Los Angeles is described in this issue. Trouble in these cases is receiving particular attention because more work of the same nature is being planned nearby; notably the outfall for the Los Angeles County Sanitation District, 9 ft. in diameter, to extend some 9,000 ft. off the beach near the San Pedro breakwater.

The relative merit of different materials for ocean outfall pipes is secondary to the question of the best type of joint. Ball-and-socket joints in diameters of 4 ft. or less have an excellent record in submarine work, but there is little precedent for the design of joints that will give good service on the ocean bottom in pipes 7 ft. or more in diameter. As the result of observing the

shortcomings of some of the outfalls just mentioned, several engineers have suggested new types of joints, some of which provide a metal ball and socket on sections of concrete pipe. Experiments or actual tests on any of these will be illuminating.

In considering designs calculated to increase strength and permanency in submarine pipe, it is well to remember that: (1) Making the pipe sections as long as is consistent with convenience in handling will give the minimum number of joints. (2) Where it is feasible to use a pipe cross-section having a flat bottom, the danger of settling is decreased. (3) Substantial foundation on a smooth grade must be provided if settling is to be avoided. This applies whether the pipe is in trench or merely laid on the ocean bottom. (4) Manholes are desirable at intervals that will enable divers to inspect the pipe interior. Experience in southern California emphasizes the importance of a firm foundation. Where a pile substructure is not feasible because of surf, and where it is found very difficult to level accurately the bottom of the trench excavated for the pipe, other means must be found for providing the required foundation. For example, it may be feasible to cover the trench bottom with a foot or two of very coarse gravel that would serve the dual purpose of leveling off irregularities in the excavation and making it possible to force grout under the pipe at intervals of section lengths, thus building up a supporting pier at each joint.

Sewer outfalls along the California coast have been well built so far as materials and contruction methods are concerned. Troubles have been largely in the design of the joints. The Hyperion outfall was in many respects without precedent and hence an element of risk was involved. Only time will tell whether the reinforcing of the joints will be a satisfactory and permanently successful job. Meanwhile, the experience thus far with this structure will be of great value to those who are designing large ocean outfalls.

Developments in Freight Terminals

A NOTABLE line of present railway activity, and one which promises to be of outstanding importance for two or three years at least, is the construction, improvement and extension of freight terminal facilities on a large scale, involving heavy individual and aggregate expenditures. This activity, which includes freight yards, city freight houses and warehouses, and rail-and-water terminals, is all based on the endeavors of the railways to increase the speed, efficiency and economy in the handling of their freight business.

Probably the largest freight yard developments are the Markham yard of the Illinois Central R.R. and the Proviso yard of the Chicago & Northwestern Ry., both in the Chicago district and each involving about $14,000,000. The former is practically completed, while the latter is being enlarged and rearranged so as to serve both the northern and western main-line districts. These are outlying yards forming the terminals for road freight trains, all movements between them and local yards or freighthouses being operated as switching or transfer service. That this arrangement is applicable also at smaller centers is illustrated by the new yard outside Toledo, Ohio, for the freight terminal of the Pere Marquette R.R.

Entire rearrangement of groups of freight terminals of several railroads has been started at Chicago on account of the straightening of the Chicago River. As the new channel will cut directly through a congested terminal district, it necessitates an interchange of property between the several railroads as well as reconstruction of track layouts and buildings. This work is independent of, but supplemental to, the extensive rearrangement of city freight terminals already carried out, as necessitated by the construction of the new union passenger station. Similar comprehensive work involving joint action of a group of railways is under consideration at Cincinnati. Two or three railroads here have already on their own account begun the work of rearrangement of their terminals.

At Boston, work is under way by the Boston & Maine R.R. for the separation of freight and passenger lines and an extensive re-arrangement of city freight terminals at a cost of about $4,000,000. At both Houston and Dallas, Tex., two or more railroads acting independently are building or planning their own freight yards and city freight stations. Similar and typical developments are under way at Kansas City; East St. Louis, Ill.; Miami, Fla.; Portsmouth, Ohio; Hartford, Conn.; Buffalo, N. Y., and numerous other points. All of the above and many other works are reported as costing at least $1,000,000 each, while similar works involving $300,000 and upward are still more numerous.

Costly freight piers and wharves include Jersey City and Norfolk on the Atlantic, and the inland Gulf ports of Mobile, Ala., and Houston and Corpus Christi, Tex., this last being a new deep-water port practically completed in 1926. With the entrance of the St. Louis-San Francisco system into Pensacola, by its connecting link now under construction, there will doubtless be considerable improvement of the water front facilities at that place.

New ore and coal shipping docks, designed specially for increased storage capacity and increased rapidity of loading, are features at some ports on the Great Lakes, where the navigation season is relatively short and the seasonal traffic is consequently intensive. Additional train-ferry steamers are also being put in service on Lake Michigan to accommodate the increasing traffic of this kind across the lake. On inland waterways, there are the new rail-and-water terminals at Cincinnati, on the Ohio, and at St. Paul and Helena, on the Mississippi.

Of special character are large city terminals for the handling of perishable freight, vegetables and fruit, with buildings for wholesale and retail marketing. Such terminals have been established recently by the Santa Fe at Chicago and by the Reading and Baltimore & Ohio jointly at Philadelphia, while the Boston & Maine has started a similar enterprise at Boston.

Marked improvements in the efficiency and economy of gravity switching at classification yards have been effected by the very recent development of car-retarders or track brakes, which have been applied already at several large yards. This plan insures greater safety also, since it is not necessary for car-riders or brakemen to travel on the cars to check and stop them. However, in some yards a special hump profile has been developed which permits the operation of cars by gravity without the use of either car retarders or car riders. Another important line of improvement is in the lighting of yards, notably by flood lighting, to give increased efficiency and safety of night work. It appears evident that we are in an era of great activity in the construction and improvement of railway freight terminals of all kinds.

Water Powers of Shannon River Being Developed by the Irish Free State

Work Now Under Way Includes the Installation of 90,000 Hp. in One Plant—Large Temporary Oil-Driven Power Plant Supplies Electricity for Great Excavating Machines

By J. K. Prendergast

Resident Engineer, Department of Industry & Commerce, Shannon Power Development, Limerick, Ireland

EARLY in 1924 a scheme for the electrification of the Irish Free State by the development of the water powers of the Shannon River, was placed before the Minister of Industry and Commerce of the Irish Free State. The scheme, with some modifications, was approved by the government in May, 1925, and the "Shannon Electricity Bill" was introduced to give it effect. This bill became law in July of the same year and in August a contract was awarded for the development of 90,000 hp., being the first portion of the scheme, or what is known as the partial development. This article proposes to describe briefly the nature and magnitude of the work involved, now in progress, and particularly the plant and machinery adopted by the contractor.

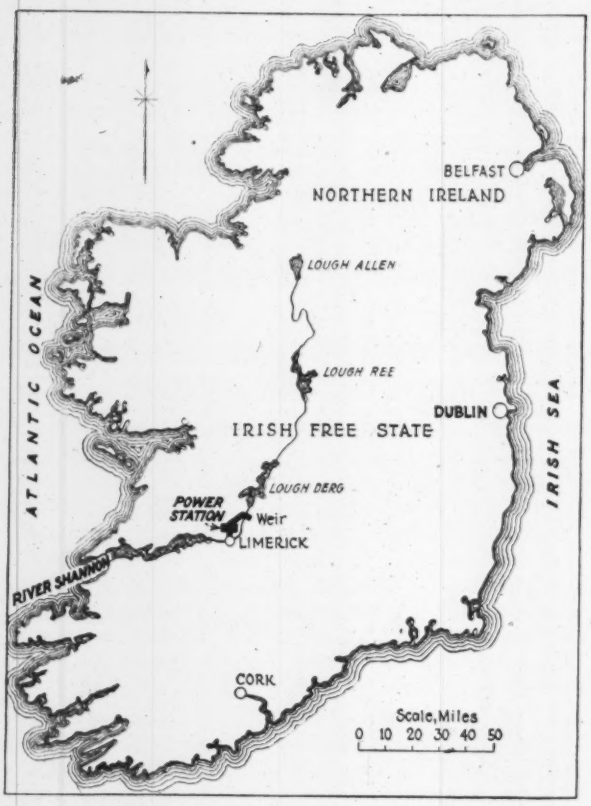


FIG. 1—IRELAND, SHOWING SHANNON RIVER AND LAKES

The Shannon is the principal river in Ireland, it rises in the northwest part of the island and flows into the Atlantic on the southwest coast. The tidal estuary of the river commences at Limerick about 60 miles from the sea. Between the river's source and the city of Limerick there are three lakes, Allen, Ree and Derg. Lough Derg is 13 miles north of Limerick and the main falls of the Shannon occur in this stretch of the river. It is proposed to develop the latent power of these falls by the construction of a weir or barrage across the river four miles below Lough Derg, and to divert the greater portion of the flow through a head-race canal 7½ miles long to a power station to be erected at the village of Ardnacrusha where the whole fall of the river between Lough Derg and Limerick amounting to 100 ft. will be utilized. A tail-race 1¼ miles long will connect the power station with the Shannon about 2 miles above the city of Limerick.

The catchment area of the Shannon is approximately 4,500 sq.miles; with an average rainfall of 37 in., and it is estimated that by the utilization of the natural storage of the lakes and the fall available, it is possible to develop 180,000 hp. installed capacity. The partial development which is now being carried out contemplates the installation of 90,000 hp.; and with the possibility of future extension as the demand for power increases, the development involves the following construction works:

(a) Embanking, dredging and regulation of the river north of Lough Derg.

(b) Embankments and control works between Lough Derg and the diversion weir.

(c) Construction of diversion weir and inlet works to the canal.

(d) Construction of head-race canal partially in bank and partially in cutting through earth and rock. The

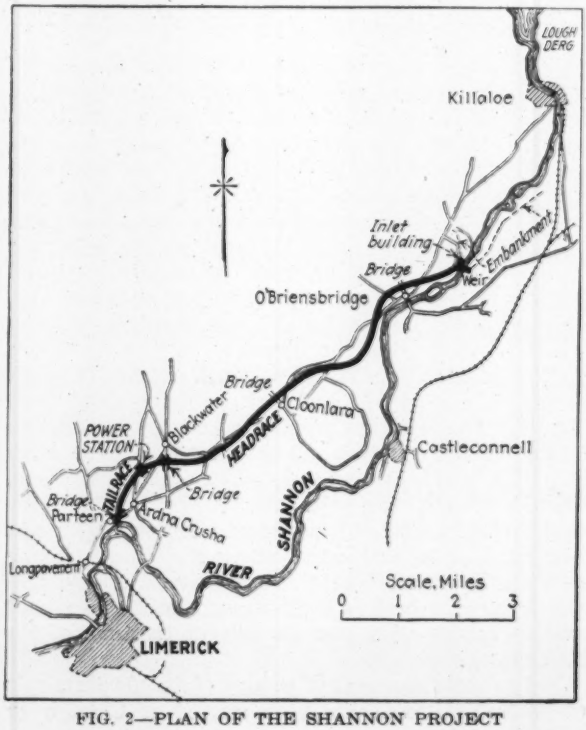


FIG. 2—PLAN OF THE SHANNON PROJECT

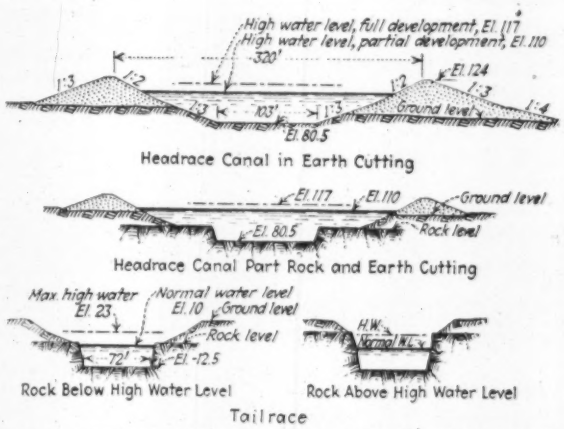


FIG. 3—TYPICAL CROSS-SECTIONS OF HEAD-RACE AND TAIL-RACE CANAL

cross-sectional area of waterway in this canal will be 9,700 sq.ft.

(e) Construction of power house, intake works and navigation locks, the power house in the partial development to have three turbines direct-coupled to vertical-shaft three-phase generators and six turbines and generators in the full development.

(f) Excavation of tail-race chiefly through rock from the power station to the River Shannon.

Approximately 10,000,000 cu.yd. of earth have to be excavated and placed in the embankments and 1,300,000 cu.yd. of rock are to be excavated. The construction of the weir, intake, power house, navigation locks, bridges, culverts and subsidiary works will involve the mixing and placing of 220,000 cu.yd. of concrete. The work is to be completed in 3½ years. Construction commenced as soon as possible after the contract was signed. The first works to be undertaken were the housing and accommodation of the working people, the transport and erection of plant and machinery and the provision of a temporary plant for power and light.

Temporary Power Supply—The contractors decided to use electric power as far as possible, and a temporary central power station containing nine units, developing

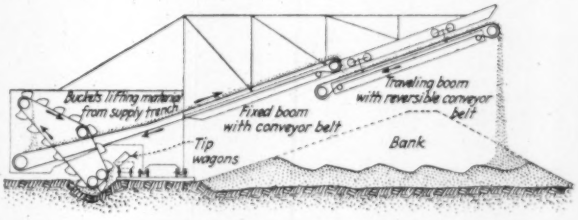
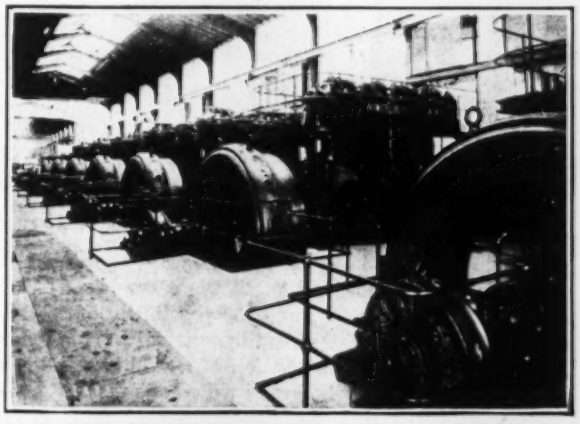

Buckets lifting material from supply trench
Fixed boom with conveyor belt
Traveling boom with reversible conveyor belt
Tip wagons
Bank

FIG. 4—DIAGRAM OF BANK-BUILDING MACHINE

a total of 4,500 hp., was erected. Seven four-cylinder and two two-cylinder crude oil engines direct-coupled to three-phase generators were adopted as the power units. The current at 17,000 v. is distributed to the various construction sites and is transformed down to suitable voltage for the various machines and for lighting and other purposes.

Excavation and Embankments—The location of the head-race canal is such that the balance of cut and fill is as economical as the contours of the country traversed will permit. The tail-race canal is practically all in deep rock cutting. The power station site excavation is partly earth and partly rock. Surface soil and dangerous earth and peat underneath the proposed embankments forming the head-race canal are being removed by small multiple-bucket dredgers mounted on caterpillars. These machines excavate and convey the soil into dumps to be subsequently re-used for the soiling of the slopes of the embankments. Excavation of the canal in earth is being carried out by six electric-driven bucket dredgers. Each of these machines has a theoretical output of 500 cu.yd. per hour, a maximum dredging depth of 55 ft. at 45 deg., and they are giving satisfaction in the heavy earth encountered. The material excavated by these dredgers is dumped into cars and conveyed to the "absetzers" or bank building machines.

The embankments extend over practically the whole length and on both sides of the canal, forming, with the excavated portion, the waterway to the power house. In some places the banks are comparatively low and in others they rise to a height of over 50 ft. The excavated material is chiefly a mixture of sand and tough, tenacious earth. The contractors did not consider it possible or economical to build the banks by the usual tipping methods from muck trains. Hydraulic sluicing methods were also considered and found impracticable. The bank building machine is an electric-driven



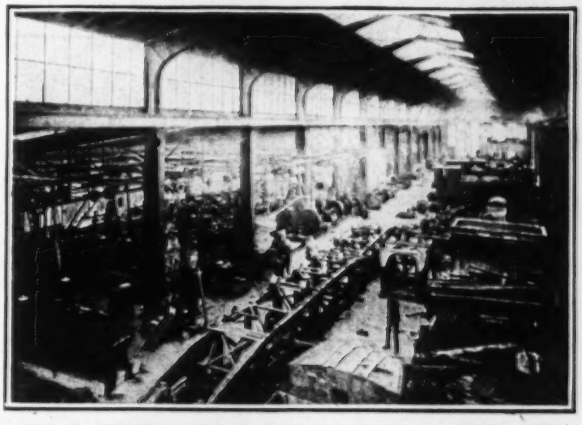


FIG. 5—TEMPORARY POWER STATION (ABOVE) AND REPAIR SHOP (BELOW)

transporter so designed that it can lift, transport and place over a wide area, the material supplied to it.

The material on arriving at the transporter is dumped into a trench which the transporter itself has excavated: from this trench it is lifted by a duplicate chain of buckets and discharged on to a continuously moving conveyor belt supported on a jib which reaches out over the bank. The material on arriving at the end of this conveyor drops on to a lower reversible conveying belt supported on a framework hung from, and capable of

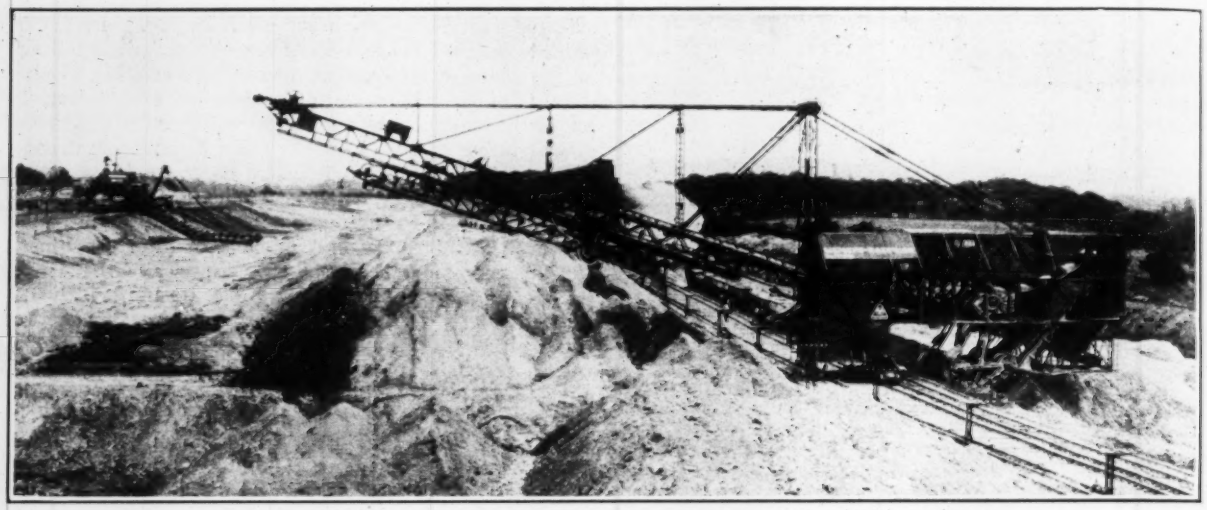


FIG. 6—BANK-BUILDING MACHINE PUTTING UP CANAL EMBANKMENT

traveling along, the main jib. By the combination of the reversible and traveling motions of the lower belt it is possible to distribute the material on to any portion of the bank. The whole machine, as a unit, travels on a wide-gage track. The railway track for transport trains containing the material passes under the portal of the machine. These machines are also equipped with pumps by which it is possible to add, where necessary, water to the material as it is being tipped into the bank.

By this machine it is possible to place the material according to its grade and quality in its most effective position in the bank; this and the possibility of adding water to any desired extent to the material as it is being tipped results in the construction of a well consolidated bank. The slewing of the heavy wide-gage track for the electric dredgers and the "absetzers" is done by a mechanical track shifter operating independently of the grading equipment.

Excavation of rock in the tail-race and in the head-race is done by electric-driven rope and pneumatic drills, blasted, and removed by steam power shovels of 2½-cu.yd. capacity. The rock is broken up into as large masses as the shovels can conveniently handle and is conveyed to 1¼-cu.yd. stone crushing machine, then mechanically conveyed into smaller crushing machines, lifted, screened, washed and conveyed to the various building sites for use as concrete aggregate, ballasting and road metaling. Rock removal at the power station and at the weir and intake works is done by cable cranes, each of 6-ton capacity. These cranes subsequently will be used for the placing of concrete formwork and handling of materials at those sites.

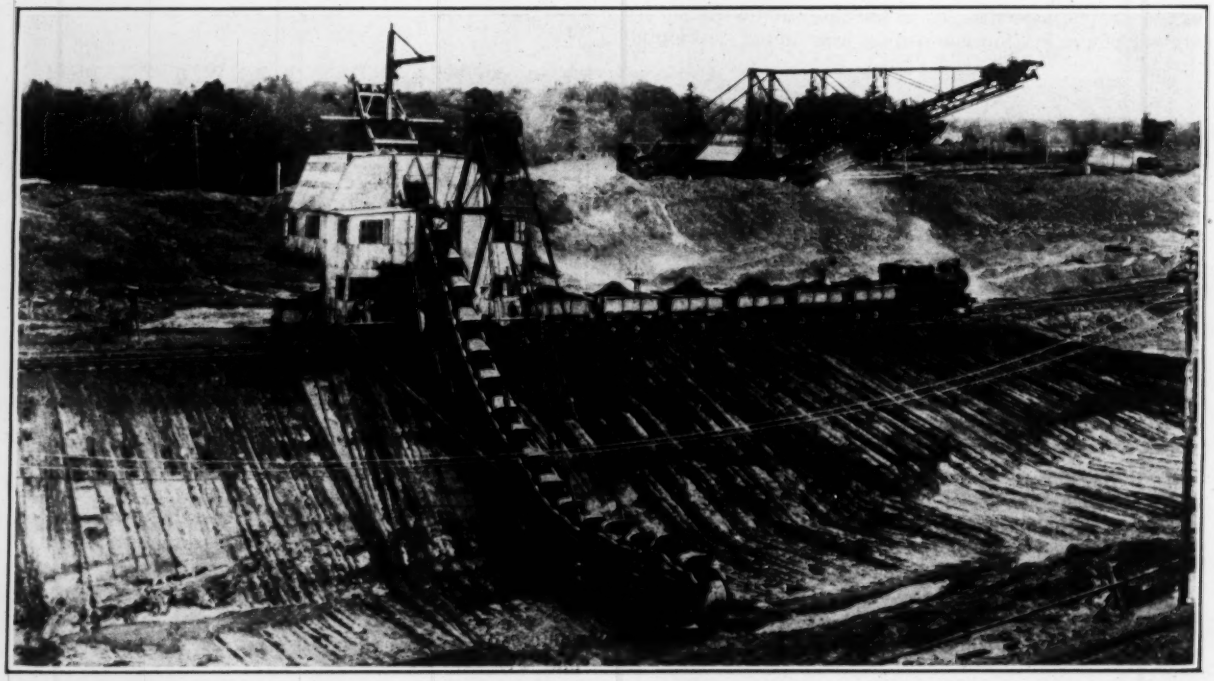


FIG. 7—MULTIPLE-BUCKET EXCAVATOR ON HEAD-RACE CANAL

Subsidiary Operations—Subsidiary works include a number of road diversions involving the construction of three reinforced-concrete bridges over the head-race and one reinforced-concrete bridge over the tail-race.

Two of these bridges will be three-span cantilever type and two will be reinforced-concrete hinged arches. The head-race canal is intersected by a number of streams which will be carried by siphons or culverts under the canal. The largest of these is the Blackwater River and to accommodate it a reinforced-concrete culvert 600 ft. long, 10 ft. 6 in. high and 14 ft. wide has been completed. The other smaller culverts, seven in all, are in course of construction, in advance of the excavation and bank building work.

The weir will be a concrete construction founded on rock, in the partial development. It will hold up a head of 24 ft. of water, and steel vertical roller sluice gates of sufficient size to discharge a full flood in the river will be incorporated in its construction. The inlet construction work will be very similar to the weir and have gates designed to regulate the flow to the power house. Piling, cofferdam work, and excavation on the weir and intake sites preparatory to placing of concrete are in progress.

Extensive workshops, repair shops, sawmills, stores, material testing laboratories have been erected, also offices and dwelling houses for the staff. Accommodation is provided for 1,000 to 1,500 workmen on the building sites, including recreation halls, canteens and playing fields. Special precautions have been taken for guarding the health of the workmen by constant medical supervision, and by the installation of efficient water supply and sanitation systems at each of the camps.

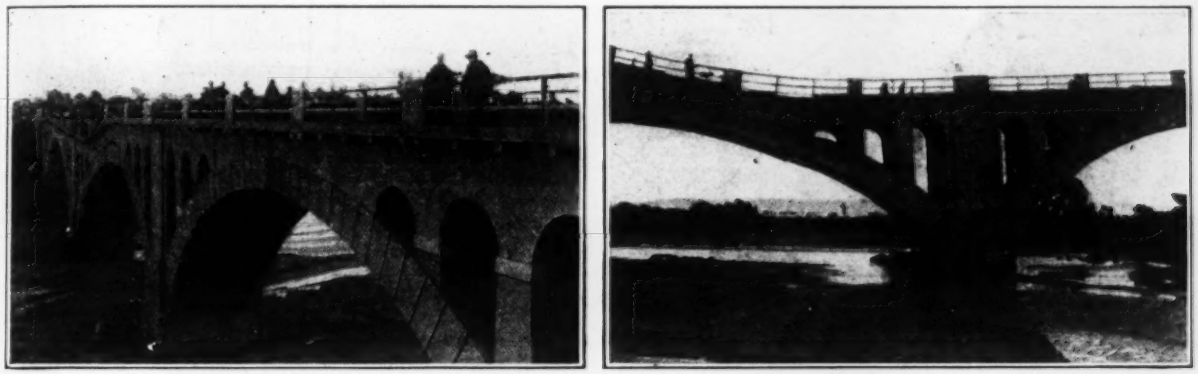
Contract for the work was awarded to Messrs. Siemens Schuckertwerke; and Messrs. Siemens Bauunion, who are associated with Siemens Schuckertwerke, were, with the consent of the Irish Free State Government, intrusted with the civil construction part of the work.

The civil construction work is being done under the direction of Prof. F. S. Rishworth, chief executive engineer, with the author as resident engineer. The civil engineer for the contractor, Siemens Bauunion, is Herr Regierungs und Baurat Heintze. The committee of experts appointed by the government in 1924 to pass upon the scheme, and who will continue to act in a consulting capacity when required, are Waldemar Borgquist, Stockholm; Thomas N. Schulz, Oslo, and Eugene Meyer-Peter and Arthur E. Rohn of Zurich.

Pier Subsidence Wrecks Concrete Arch Bridge in Rumania

A LARGE concrete-arch bridge on a main railway line in Rumania was wrecked on June 5, 1926, by subsidence of one of its river piers. The effect on the superstructure is brought out in the accompanying views, reproduced from *Beton und Eisen*, of Aug. 20, where the failure was described by E. Proksch, of Bucarest.

The bridge, built five years ago, crosses the Milcov River near Focsani. It consists of three spans of 30 m., having reinforced barrel arches of about 22-ft. rise and 4-ft. crown thickness. The superstructure was single track, but the piers had been constructed long enough for future double tracking. They were built by enlarging old stone masonry piers by jacketing 4½ ft. thick, carried the same depth as the old piers, about 12 ft. below river bottom. The subsoil is described as shingle, or coarse gravel. Apparently the piers lacked riprap protection.



TWO VIEWS OF WRECKED MILCOV RIVER BRIDGE, RUMANIA; THREE ARCHES OF 30 M. (98½ FT.)

Just previous to the wrecking of the bridge a rain of cloudburst intensity, lasting 18 hr., had fallen over the drainage area. Several small reservoir dams in tributary streams failed and increased the river flow. Unprecedented flood discharge resulted, water level being 4 ft. higher than in the previously recorded extreme flood. The result was that the river bed scoured heavily at the railway bridge, evidently undermining one of the river piers. The pier settled about 4 ft., apparently going down quite vertically, without tipping, possibly as a result of the restraining effect of the arches. The settlement, in turn, resulted in the fracture of the adjacent arches.

Calculations on Monolithic Concrete Sewers

In the article on structural and hydraulic features of the Los Angeles north outfall sewer published in the issue of Jan. 20, p. 119, the exponent 2 was omitted in an expression below Fig. 1, the correct form being $A = (\text{sewer depth in ft.})^2 \times 0.958193$. In this figure, the 186-lb. pressure occurs between the fourth and fifth tile instead of in the second tile as indicated. Also the author states that the heading he used on the middle column of the last table should be "average cover" and not "average depth to subgrade."

Cuba Begins New Central Highway 700 Miles Long

Contracts Aggregating Over $75,000,000 Awarded for Paved Highway Extending Virtually the Length of the Island

By E. Ruiz Williams
Engineer, Havana, Cuba, for Warren Brothers Co., Boston, Mass.

THE longest paved road ever put under contract at one time is now being constructed in Cuba. This road, known as the Central Highway, runs from Pinar del Rio to Santiago, 705.6 miles, which lacks only about 200 miles of being the full length of the island. At the unit prices bid and the estimated quantities, the contract price is $75,870,000. This gives a cost per mile of $107,465 which includes grading, drainage, bridges and a large amount of incidental work. The road is paved its full length 20.66 ft. wide with 5.64-ft. shoulders, about one-sixth of the length being granite block on concrete base and the remainder being Warrenite-bitulithic on concrete base. All bridges and structures are steel and concrete. In brief the new Cuban road compares favorably in structure with the best trunk line state highways of the United States.

FIG. 1—MAP OF CENTRAL HIGHWAY OF CUBA

Contracts and Finance—The formal contract for the Central Highway was signed at Havana, Feb. 19, 1927, by the President of Cuba, the Secretary of Public Works, by Warren Brothers Co., of Boston, and by the Associated Cuban Contractors, Inc. Simultaneously the government entered into a contract with the Chase National Bank of New York for a credit of $10,000,000 in anticipation of Public Works revenues for the fiscal year ending June 30, 1931, in order to expedite the construction. It calls for the completion of the work in five years according to plans and specifications made a part of the contract. The division of the contract is approximately 70 per cent to the Warren Brothers Co. and 30 per cent to the Associated Cuban Contractors, Inc. Specifically the Cuban company has the contract for the road in Matanzas and Santa Clara provinces and the remainder of the road goes to the American firm. The bids were received on a unit price basis on estimates of quantities made by the Cuban engineers.

It is provided in the contract that should the costs of labor, or the principal materials, such as cement, asphalt and granite blocks, be more than 5 per cent less than the estimate of cost of said units filed with the bid, 80 per cent of such excess shall be for the benefit of the government; conversely, should the cost of labor and materials be more than 5 per cent above the estimate of cost, 80 per cent of such excess shall be added to the contract price. As the work covers a period of five years, a sliding scale was considered a reasonable and equitable provision that will safeguard both the contractor and the government.

The contract stipulates that the work shall be prosecuted in each of the six provinces at the same time, and shall be started in each within 30 days of the signing of the contract. Bid bonds, or surety bonds, were not permitted under the Department of Public Works regulations. A certified check of $500,000 on a member bank of the Havana clearing house was required to accompany the bid of each contractor. A cash bond of $1,000,000 was required to be deposited by Warren Brothers Co., and $600,000 by the Cuban company at the time of signing the contract, to be released prorata, upon completion of the six-year guarantee of each 5-kilometer section.

The several special taxes levied for a period of ten years from which the funds to pay for the work will be derived and the estimated revenues for each year are:

Traffic and locomotion— Estimated to yield per year	$1,500,000
Gasoline tax (at source) 10c. per gal	3,000,000
¼ of 1 per cent gross sales tax	6,000,000
Annual budget credit	5,000,000
50 per cent annual surplus above budget	1,500,000
Increased duties 3 to 10 per cent	2,500,000
½ of 1 per cent of all outgoing funds	1,500,000
2 per cent real estate property tax	1,500,000
Total estimate	$22,500,000

These special taxes should produce increased revenue from year to year as the public improvements are completed. The yearly distribution of the special funds for public works on the basis of $20,000,000 per year revenue is given in the following table:

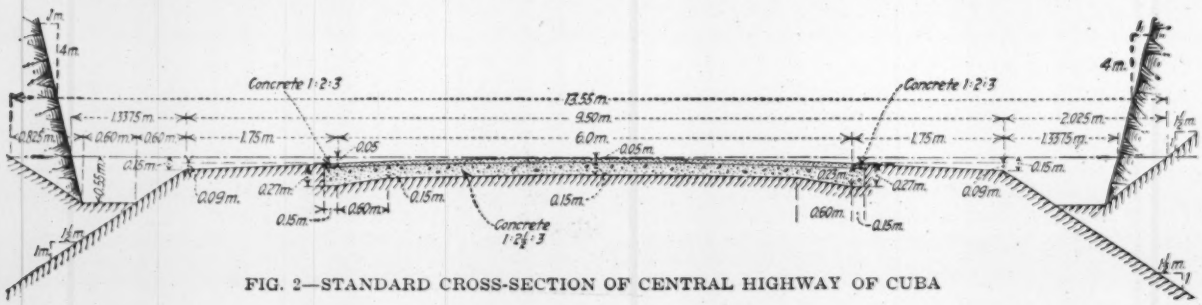


FIG. 2—STANDARD CROSS-SECTION OF CENTRAL HIGHWAY OF CUBA

Item	Per Cent	Total
Roads	45	$9,000,000
Water and sewers	10	2,000,000
Schools	5	1,000,000
Hospitals	5	1,000,000
Buildings	5	1,000,000
Havana (beautification and improvement)	20	4,000,000
Unforeseen	10	2,000,000
Total		$20,000,000

These special taxes were put in effect July 15, 1925, so that by July, 1927, there will have been collected

FIG. 3—TYPICAL SCENE ON NEW ROAD
View shows types of highway in Havana and Matanzas provinces which will be reconstructed for new central highway. The royal palms are everywhere seen in these provinces.

two years' taxes, providing about $18,000,000 for the central highway, based on the above allotment for roads. The load provides that the funds collected shall be apportioned equally each year among the six provinces.

In order to make possible the speeding up of the work in anticipation of collection of the special taxes, the Cuban government has contracted with the Chase National Bank of New York to provide an advance of $10,000,000, as may be required, at 6 per cent interest, the principal to be paid after 1931 out of funds collected from the special taxes after that date.

Location and Design—The central highway, as shown on the map, Fig. 1, begins at the city of Pinar del Rio, the capital of Pinar del Rio province, about 80 miles from Cape San Antonio, the western tip of the island, and extends through the six provinces: Pinar del Rio, Havana, Matanzas, Santa Clara and Camagüey and ends at Santiago, the capital of Oriente province, 100 miles from Cape Maisi on the extreme eastern tip. The total length is divided into 32 sections of from 30 to 35 km. each. There were altogether 53 items on which unit prices were bid in each section. Havana province, the most densely settled, has a population of 890,609, while the province of Camagüey, the most sparsely settled, has a population of 241,599. The total population of the six provinces, corrected up to 1925, is 3,368,923.

The standard road sections are shown by Fig. 2. It is the present intention to use granite blocks on the dense traffic sections near the important cities. Both Warrenite-bitulithic and granite are to be laid on a 1:2½:5 portland cement concrete base 6 in. thick in the center and 9 in. on the sides. On account of the greater cost of granite blocks, the extent of their use may be reduced from the amount contemplated in the specifications.

Standard bridge designs have been adopted. Spans of 30 m. (about 100 ft.) or under are of reinforced concrete. Bridges greater than 30 m. are of steel under standard designs by J. A. L. Waddell, consulting engineer of the Cuban government on steel bridges.

Quantities and Conditions—The principal construction volume and quantities of materials for the Central Highway are:

Construction	Quantities
Excavation—Earth	3,648,196 cu.m. (1¼ cu.yd.)
Excavation—Rock	695,226 cu.m.
Embankment	5,562,927 cu.m.
Concrete in structures	300,878 cu.m.
Granite blocks	1,121,827 sq.m. (1.2 sq.yd.)
Warrenite-bitulithic	5,562,927 sq.m.
Concrete curbing	93,305 lin.m. (3.28 ft.)
Concrete headers	2,011,445 lin.m.
Concrete pipe	28,551 lin.m.
Materials	
Crushed stone	1,700,000 cu.m.
Sand	1,250,000 cu.m.
Portland cement	2,250,000 bbl.
Asphalt cement	60,000 tons
Steel bars	5,876,219 kg. (2.2 lb.)
Steel bridges	5,097 tons
Granite blocks	40,000,000 blocks

Pinar del Rio and Oriente provinces are mountainous and wild. Indeed, of the total length of over 700 miles, about one-third is new location through rough country or jungle where there is now only a trail at best, and about one-third follows close to the line of the usual country dirt road. These conditions apply particularly

FIG. 4—CENTRAL HIGHWAY NEAR SANTIAGO
Hill in the foreground is the approach to San Juan Hill; the tree is a Corojo Palm.

to the work in the provinces of Santa Clara, Camagüey and Oriente. Sand, stone water and other road materials in many sections of these provinces must be hauled for long distances to the point of use, making the construction work both difficult and expensive.

Direction—The construction of the new road is under the direction of Gerardo Machado, President of Cuba, and Carlos Miguel de Cespedes, secretary of public works. The engineers for the Cuban government are: M. A. Coroalles, M. Am. Soc. C. E., and E. Duque Estrada, M. Am. Soc. M. E. Both of these engineers were trained in engineering schools in the United States, Mr. Coroalles at Rensselaer Polytechnic Institute and Mr. Estrada at Stevens Institute.

New Gulf Harbor and Port at Corpus Christi, Texas

Inland Port with Basin, Wharves, Freight Sheds, Railway Lines and Industrial District—Reached by 21-Mile Ship Channel Through Shallow Bay—Earth Levees and Rock Breakwater

WITH the rapid industrial and agricultural development of Texas in recent years there has appeared to be opportunity for the creation of a new port on the 300-mile stretch of coast line southwest from Galveston to the Rio Grande, the international boundary. About five years ago, therefore, the city of Corpus Christi decided to seize this opportunity and to establish such a port on the landlocked harbor of Corpus Christi Bay. This bay, with an area of about 140 sq. miles, is reached from the open water of the Gulf by the Aransas Pass, a natural channel about 200 ft. wide, some 21½ miles from Corpus Christi. The main part of the city, about three blocks back from the shore, is on a bluff about 40 ft. high, the back country rising about 1 ft. per mile to the west. Four railways enter the city. This new port was formally opened in September, 1926.

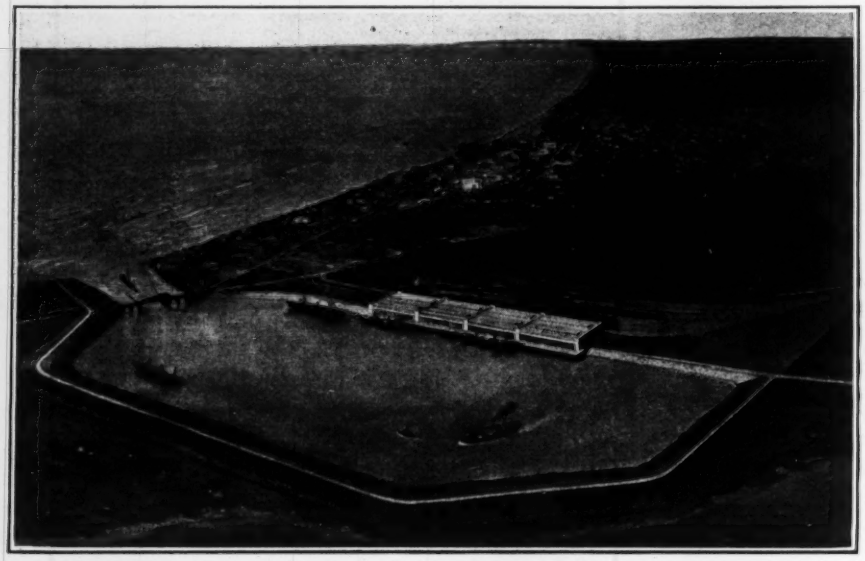


FIG. 1—NEW HARBOR AT CORPUS CHRISTI, TEX.
View looking south. Entrance from Corpus Christi Bay at left. Nueces Bay in foreground. Breakwater in front of city. Filled land behind transfer shed for railway yard, warehouses and industrial district.

Since the depth of the bay averages only 8 to 14 ft., the assistance of the federal government was sought for dredging and maintaining a ship channel from Aransas Pass to the city, a distance of about 21½ miles. A survey for this work, authorized by Congress in 1921, provided for a channel having a minimum depth of 25 ft. of water on a bottom width of 200 ft. The Chief of Engineers, U. S. Army, recommended that this project should be undertaken, provided that the city would build a safe and adequate harbor as the terminus for the ship channel. Under the agreement, the city's work included: (1) A turning basin 1,000x3,000 ft., and 25 ft. deep, with an entrance channel of the same depth and 200 ft. bottom width to connect with the federal government's ship channel; (2) a combined railway and highway drawbridge across this entrance channel; (3) extension of the city's rock-fill breakwater to protect the exposed face of the harbor; (4) a levee between the harbor and Nueces Bay; and (5) wharves for shipping, with mechanical equipment, railway tracks and highways.

Although the bay is landlocked, its area is so large and the strip of land separating it from the Gulf is so low that the storms and hurricanes of the Gulf region cause heavy and destructive waves. The normal tidal range is 1 ft. After a devastating storm in September, 1919, as recorded in *Engineering News-Record* of Nov. 13, 1919, p. 848, the city built a rubble mound breakwater in the form of an arc protecting the principal business section, together with the municipal pier (1,000x200 ft.) and the pleasure pier (1,150x16 ft.), both these piers projecting directly from the shore line. The former pier has concrete walls with earth fill, and the latter is of timber. This breakwater has been extended on straight lines at both ends, a 450-ft. opening being left for the ship channel.

In view of the great damage and property loss resulting from the storm of 1919, the Texas legislature relinquished the ad-valorem property taxes of seven counties in this district for a period of 25 years, in order to provide funds for the construction of shore protection works to prevent damage in future storms. In this way about $2,000,000 was available, part of which could be utilized in the construction of protective levees around the port or harbor site. As this amount was insufficient to provide the safe and adequate harbor stipulated by the federal government, Nueces County voted an additional bond issue of $1,000,000 and authorized the preparation of plans for harbor works that would meet the approval of the War Department.

To provide against damage from storms, the turning basin, with its wharves, sheds and other facilities, was not located on the shore side of the city, but is on the north side, protected by a levee carrying a railway and highway (Fig. 1). It is reached by an entrance channel 900 ft. long with 200 ft. bottom width and 30 ft. of water, forming an extension of the government ship channel. This entrance is protected by the breakwater, as noted above. A bascule bridge carries the railway and highway across the channel.

The turning basin, 1,000x3,000 ft., has a depth of 30 ft. of water, and is formed with side slopes of 1 on 3, except where the wharves are built. From the entrance channel, a levee has been built along the north and west sides of the basin, to an elevation of 15 ft.

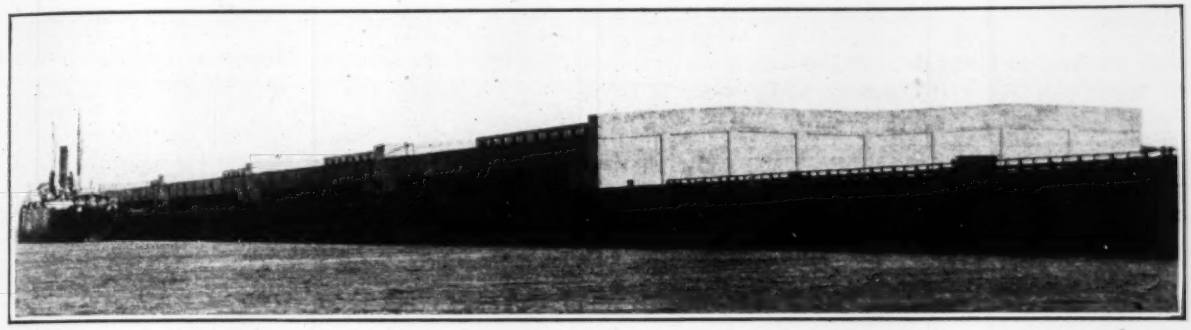


FIG. 2—WHARF AND FREIGHT SHED AT CORPUS CHRISTI, TEXAS

above low tide. This embankment is formed of shells, clay and river silt deposited by the hydraulic dredge at work in the turning basin. The side slopes of 1 on 10 are protected from erosion by a 6-in. soil blanket planted with Bermuda grass, and six rows of salt cedars planted along the bottom of the outer slope. It is expected that eventually the city will build a highway along this levee giving access to wharves to be built later along the north side of the basin.

A levee along the south side of the turning basin was built with stiff clay from a railway cut about seven miles distant. Its front slope, for the entire 3,000 ft., is protected by a 30-in. revetment of one-man and two-man stones. Behind this levee is deposited the material dredged from the basin and not required for the north and west levees. In this way there is being formed an industrial site of about 100 acres, with an elevation of 15 ft., which it is planned to utilize for warehouses, railroad yards, a grain elevator and other facilities required for a modern port. On the north side of the turning basin, adjacent to the Southern Pacific Ry., about 30 acres have been filled.

Wharf and Shed—In front of the south levee is a wharf of creosoted pile and timber construction, 1,200 ft. long and 112 ft. wide; the floor of which is extended back over the dredged fill. As shown by Fig. 3, upon this wharf is a one-story freight shed or transfer shed 160 ft. wide. Along the front of the building, on the wharf side, is a 22-ft. platform. At the rear is a 10-ft. platform served by railroad tracks and a highway leading to the city. Fire protection for the docks and water supply for shipping are supplied by pipes connected with the city water mains from a standpipe on the bluff.

The transfer shed is of steel-frame construction and is designed to resist a wind pressure of 40 lb. per square foot, equivalent to a velocity of 120 m.p.h. The building, as shown in Fig. 3, has five rows of columns spaced 16 ft. c. to c. longitudinally and forming four 40-ft. bays, with 12 ft. clearance under the roof trusses, which have two monitors for light and ventilation. The end and cross walls are of concrete, while the sides have corrugated galvanized-iron sheathing. On the dock side, there is a continuous row of openings 15½x10 ft., separated only by the wall columns and fitted with rolling steel doors. On the track side, each alternate bay has a similar door 12x8 ft. At the ends and at the intermediate firewalls, the sides have 12-in. concrete walls 20 ft. long to serve as fire stops. The roof is of four-ply composition covering a deck of 2x6-in. tongued-and-grooved plank carried by wood purlins on trusses.

For a width of 90 ft. the floor of the wharf and building is of creosoted joists carried on the creosoted pile bents, with a solid deck of 3x8-in. planks covered with 1 in. of asphalt. The remainder of the shed floor is of asphalt on crushed limestone foundation resting on the ground. Along the front of the wharf is a fender consisting of piles in line with the wharf bents, with two lines of 10x12-in. waling pieces between the rows of piles, and with fillers of the same size between the outer or fender piles. The head of each fender pile is held to the cap of the wharf trestle by a U-strap, and behind the heads of the fender piles is a 10x12-in. stringer bolted to the 10x10-in. stringer of the wharf.

The 1,200-ft. freight shed is divided into four sections by 12-in. fire walls, untreated piles being used to support that part of the walls in the rear of the levee.

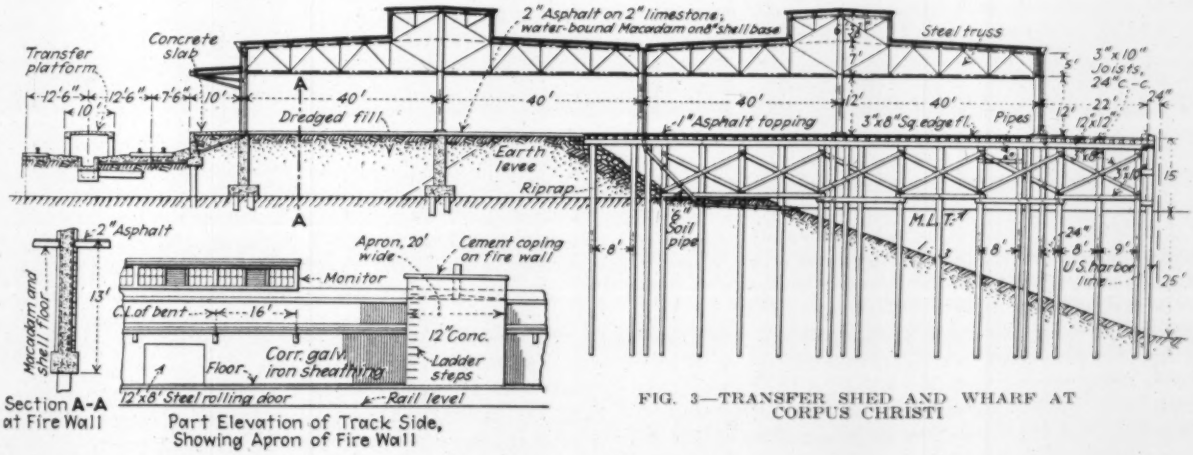


FIG. 3—TRANSFER SHED AND WHARF AT CORPUS CHRISTI

To make the fire walls effective, they are carried down through the wharf to the water level, the footings being supported on piles driven to that level. Furthermore, as shown in Fig. 4, the wall beneath the wharf is extended at right angles to form an apron about 18 ft. long, between two of the pile bents and behind the fender piles. In the deck of the wharf, an 18-ft. strip of 6-in. concrete paving interrupts the plank and asphalt floor so as to complete the fire stop. In planning for this concrete work below the timber deck, the contractor was not allowed to drive spikes into the creosoted piles to support the forms, but had to support them by bolted frames clamped around the piles. The erection of the steel superstructure is shown in Fig. 5.

Adjoining the west end of the original wharf there is now an open wharf of timber construction on creosoted piles. This wharf, shown at the right in Fig. 2, is 40 ft. wide and 400 ft. long and has two railway tracks to allow direct handling of cargo between cars and ships. It is connected with the shore on the south side of the turning basin by a railway trestle of creosoted timber construction, 600 ft. long. Adjacent to the government channel at the shore line of the bay a slip has been dredged 225 ft. wide and 10 to 25 ft. deep, to

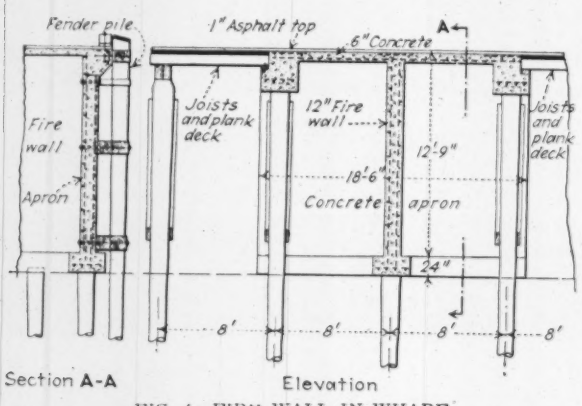


FIG. 4—FIRE WALL IN WHARF

facilitate the construction of slip ways and other facilities for a ship repair yard.

Breakwater and Entrance Channel—The breakwater already noted has a total length of 12,300 ft. and is about 2,000 ft. from the shore line, in 8 ft. of water. It is of the articulated type, having sections of varying lengths separated by 300-ft. gaps, except that for the ship channel the gap is 450 ft. A core of rubble limestone with blocks of 15- to 200-lb. weight is protected on both sides and on the top by blocks weighing 3 to 10 tons, with an average of 6 tons. These blocks are placed by a floating derrick. The construction requires about 14 tons per lin.ft. for the core and 15 tons for the slopes and crest. A future crest of concrete blocks is provided by the plans.

The bridge over the entrance channel is of the trunnion bascule type, with through trusses and a single leaf of 124-ft. span, giving an opening of 110 ft. between piers or 90 ft. clear between fenders. It carries a single railroad track, a 30-ft. roadway with street-car track and a 6-ft. sidewalk, with a total width of 52 ft. The paving is of 3½-in. and 2½-in. creosoted wood blocks on the roadway and sidewalk respectively, with creosoted sub-planking 2x6-in. and 2x4-in. respectively. With two 100-hp. electric motors, the bridge can be opened in one minute, while a 25-hp. gasoline engine for

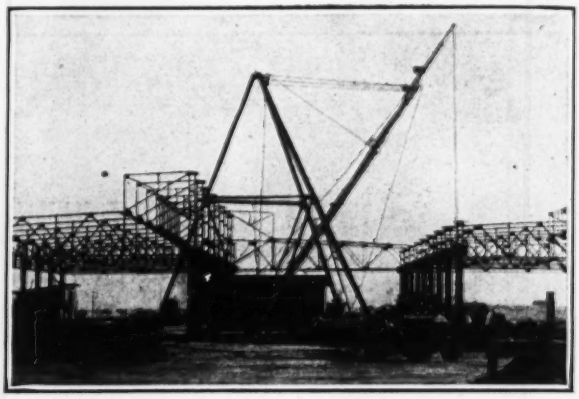


FIG. 5—ERECTION OF STEEL FRAME DOCK SHED
Tall gin-pole derrick with hoist line handled by tractor.

emergencies can open it in 10 minutes. Reinforced-concrete spans for the approaches, making a total length of 260 ft. for the bridge, are paved with 2 in. of rock asphalt on a reinforced-concrete base.

Ship Channel—The channel dredged by the War Department through Corpus Christi Bay from Aransas Pass to the new port is 21 miles long, having a depth of 25 ft. of water on a bottom width of 200 ft., with side slopes of 1 on 3. The total excavation was 15,869,556 cu.yd. and the contract cost was $1,762,183. This work was done by the Atlantic, Gulf & Pacific Co. and the United Dredging Co.

Port Management—The operation of the port of Corpus Christi is under the direction of the Nueces County Navigation District, with Robert Driscoll as chairman of the board of commissioners. To insure public control, the Navigation District has acquired all property adjacent to the turning basin, including the filled areas mentioned, and is holding this property subject to lease for industrial and shipping purposes. The government ship channel from the Aransas Pass to the new harbor was completed during July, 1926, and the terminal facilities were sufficiently advanced to warrant formal opening of the port on Sept. 14, 1926. All the work described has been completed.

Engineers and Contractors—For the work for the city and navigation board, the contractors were: Dredging the turning basin, 3,700,000 cu.yd. at 9.8c.; and 75c. per sq.yd. for 6-in. soil blanket sodded with Bermuda grass; R. A. Perry, Galveston, Texas. Pile wharf, transfer sheds, railroad tracks, highways and fire protection system: Sumner Sollitt Co., San Antonio, Texas, $770,000. Open wharf extension: Sumner Sollitt Co., $106,000. Bridge over entrance channel: Wisconsin Bridge & Iron Co., Milwaukee, Wis., $400,000. Breakwater, extension 8,100 ft., with 107,500 tons for the core and 90,600 tons for slopes and top: J. De Puy, San Antonio, $3.98 and $4.40 per ton for stone up to and over 200-lb. weight, respectively; total contract, $836,000.

Plans for this entire port project, excepting the government channel, were prepared by the late Edward E. Sands, and by Robert J. Cummins, both consulting engineers and both of Houston, Texas. Mr. Sands died before the work was started and the work was carried to completion by Mr. Cummins, with J. F. Coleman, of New Orleans, collaborating in all preliminary negotiations with the federal engineers, the awarding of contracts and at various times during the progress of the work. Construction work from inception to completion was in charge of C. J. Howard as resident engineer.

Chlorination Reduces Foaming in Imhoff Tanks

Working Scale Trials at Lufkin, Tex., Indicate that Pre-Chlorination with 3 P.P.M. Will Control Foaming

By Chester Cohen
Sanitary Engineer, State Department of Health, Austin, Tex.

During the summer of 1926 the Engineering Division of the Texas State Department of Health was requested by the city authorities of Lufkin, Tex., to assist in correcting "foaming" conditions at the local sewage-works. The gas vent walls of the Imhoff tanks had already been raised with flash boards to an elevation 2 ft. above the flow level. Daily hosing of the vents and frequent sludge withdrawals had proved inadequate and the foaming continued. Addition of lime to the vents and sludge digestion chambers produced slight improvement but temporary relief only. The liquor in the foam and in the gas vents beneath had an alkalinity of pH 7 to 8. During the periods of serious foaming the gas evolved contained hydrogen sulphide in high percentage and brought complaints of odors by nearby residents.

Believing that foaming conditions were largely due to definite physical-chemical conditions of the material in the gas vents in combination with the quantity and quality of gas resulting from certain predominating types of biological organisms or bacteria—and possibly both—the use of chlorine was decided upon as a means of killing off these types, or at least inhibiting their activity. Experience in support of this view was had by the writer at Austin, Tex., during the spring of 1926 when, in co-operation with The Chlorine Institute of New York City, a study was made of the effect of applying chlorine to the inflowing crude sewage entering one of the Imhoff tanks. It was fairly well established that relatively small chlorine dosages applied to the sewage entering the tank reduced the tendency to foam and produced a more satisfactory tank effluent.

Use of Chlorine—With probable reasons for foaming as stated, and with the Austin experiences further justifying it, the Lufkin tank influent was dosed with 20 p.p.m. chlorine, using a Wallace & Tiernan solution feed type of chlorinator. The chlorine applied caused the black liquor in the flow chamber to take on a milky appearance, due to the destruction of hydrogen sulphide and subsequent precipitation of finely divided sulphur. Owing to the high content of hydrogen sulphide the entire 20 p.p.m. of chlorine was consumed and no residual "free" chlorine could be detected in the tank effluent by use of the orthotolidin test. As a result of this pre-chlorination treatment a reduction of the rate of foaming was soon noticeable and became more so with continued application, as will be later shown.

Realizing that the effect produced, however desirable it might be, was too expensive, it was decided to attempt reduction of the chlorine dosage. Accordingly but 6 p.p.m. of chlorine (calculated on the average daily flow) was applied continuously to the influent (crude sewage). Within 24 hr. the foaming in the tank so treated had almost entirely subsided. For two weeks this treatment was continued with successful results. With the subsidence of foaming and also attendant diminution of hydrogen sulphide in the flow chamber of the tank, as well as the gas from the vents, the complaints from odors practically ceased.

The chlorine in no way adversely affected the final results. If anything, the pre-chlorination aided the sprinkling filter beds. The Imhoff tank effluent delivered to the filters contained less suspended matters. As expected, the tank effluent had a greater stability as a result of pre-chlorination in that at least a portion of the hydrogen sulphide had been destroyed and many of the numerous putrefactive organisms as well. The filter effluent had a continuous stability of 98 per cent. It should again be emphasized, however, that the tank effluent contained at no time any residual *available* chlorine.

It was later decided to return to conditioning the sludge and scum in the vents through application of lime—because of the greater economy and because of the success had with the lime treatment by other investigators. For some unaccountable reason the second trial with lime again proved to be unsuccessful and within a few days foaming was increasing rapidly.

Pre-chlorination—A return to chlorine was made but this time the solution was fed directly into the sludge chambers instead of into the crude influent. Although similar treatment without success had been previously applied to foaming tanks at Fort Worth, Tex., by Mahlie of the city of Fort Worth, and at Dallas, Tex., by Whedbee of the State Department of Health and Enslow of The Chlorine Institute, it was decided to try this method at Lufkin. A third failure of this method of dosing resulted. The failure of this treatment at Lufkin, also, would seem to indicate that reduction of foaming at this particular plant was not brought about by any chemical reactions involving chlorine. Since the reduction of foaming results from feeding into the digestion compartment chlorinated solids separating out of the pre-chlorinated crude sewage, and what little interchange exists through the slot between the chlorinated liquor in the flow compartments and the liquor in the digestion chamber, it would appear that the reduction of foaming is effected by the elimination of definite organisms entering the digestion chamber and *probably* also the inhibition of certain organisms already in the chamber.

Certain investigators believe that chlorine, like many germicides, exerts a "selective" killing action on living organisms. It may well be that in this supposition lies the explanation of the efficacy of chlorine in eliminating or reducing the foaming of Imhoff tanks.

Having tried lime treatment and direct chlorination we returned to the pre-chlorination treatment of the crude sewage at a rate of 6 p.p.m. chlorine. The results were satisfactory. A necessary shutdown of the chlorinator was followed within 10 days by foaming, but renewal of pre-chlorination stopped the foaming within 24 hours.

Later it was decided to attempt a still further reduction of the pre-chlorination dosage, this time to 3 p.p.m. Even this small dosage appeared to reduce the foaming noticeably. It should be stated that neither the 3 or the 6 p.p.m. dosages afforded sufficient chlorine to leave any residual chlorine in the tank effluent nor was sulphur precipitation observed to any noticeable extent. The odors around the plant were nevertheless effectively reduced and the tank effluent was of more satisfactory quality than prior to the pre-chlorination procedure.

Still more interesting, perhaps, is the fact that the most recent results of the test show that it is apparently unnecessary to apply the treatment *continuously* over the 24 hr. for foaming prevention alone. If, however, odor reduction is desired, continuous chlorination is naturally more efficacious since at night odors are usually at the maximum.

The final test indicates that foaming is controlled through the process of pre-chlorination during the period 8 a.m. to 5 p.m. daily at a rate of 3 p.p.m. chlorine calculated for the average flow in gallons per minute during the test period, which extended through 60 days of very warm and 30 days of cool weather. Through this procedure a further chlorine economy results and so far, after 90 days' trial, this procedure has proven a success with regard to foaming control at the Lufkin sewage-works, and that without impairment of sludge digestion.

Concrete-Cased Steel Viaduct with Special Expansion Joints

Tunnel Approach Viaduct in Jersey City Has Split Columns at Expansion Points—Floor Joints and Railing

CERTAIN special features of construction distinguish the approach viaduct of the Holland Tunnel, now being built by the New Jersey highway commission just west of the westerly end of the tunnel, in Jersey City. The structure extends from the tunnel plaza to the top of the Palisades about half a mile west of the plaza. Except at the east end it is of steel construction. All the steelwork is covered with concrete as a protection in place of paint, as comparative estimates of cost indicated that the concrete covering is cheaper when maintenance is taken into account. An unusual construction of the expansion joints was necessary because of the concrete protection. Finally, a very substantial and thoroughly anchored form of concrete balustrade has been developed to assure the safety of vehicles using the viaduct.

Expansion Joints—On account of the concrete covering of the steel structure, the usual sliding expansion joint could not conveniently be made. Expansion of the structure, therefore, is provided for by means of a double flexible column at the expansion points as shown in Fig. 1, a photograph of a portion of the structure under construction.

The expansion joint in the bridge floor is made as shown in Fig. 2. Each of the two flexible columns carries a cross-girder, the upper part of which is shown. A plate is fastened to the top flange of one of the cross-girders and is loosely supported on the top flange of the other cross-girder. To this plate and to the flange of the first cross-girder is fastened a vertical plate, supported by an angle and brackets. Another vertical plate, supported in a similar manner and parallel to the first, is fastened to the top flange of the second cross-girder. The two plates are about 1 in. apart, and their top edges are brought to a height just below the finished pavement surface conforming to the crown of the roadway. The space between the two plates is filled with asphalt mastic.

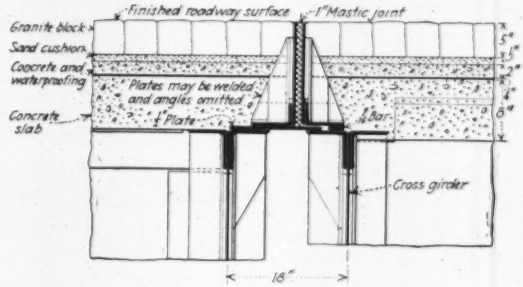


FIG. 2—ROADWAY EXPANSION JOINT (LONGITUDINAL SECTION OF ROADWAY)

Concrete Protection—Two types of concrete covering were used on the viaduct: form concrete and gunite. Generally the form concrete is used on the surfaces exposed to view, that is to say, usually on the outside of the trusses, girders and columns; the rest of the steelwork is covered with gunite. The reason for this choice of materials is that it was believed that sharper outlines and a more pleasing effect could be produced effectively and cheaply with form concrete than with a gunite coating.

Typical details of the protection and its reinforcement are shown in Fig. 3.

The form concrete is 1:1½:3, the coarse aggregate being pea gravel. The concrete is anchored by clips through holes in the webs of the steel girders and by rods bent around the flanges. The gunite protection, made with 1:3 mixture, is held in place by horizontal rods fastened to the girder work through holes punched for the purpose, and by wire mesh attached to these rods.

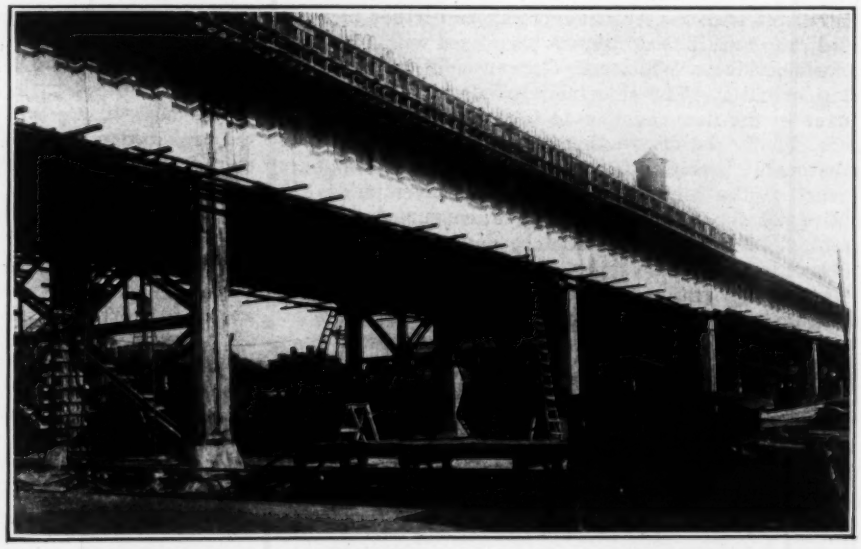


FIG. 1—EXPANSION COLUMNS OF TUNNEL APPROACH VIADUCT

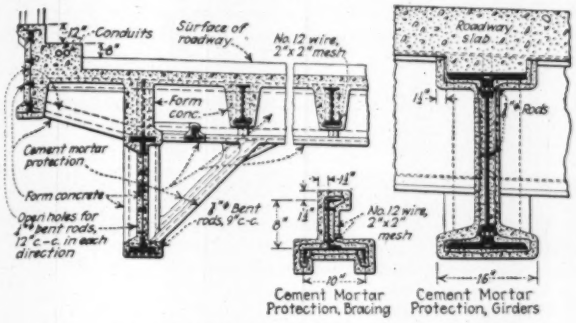


FIG. 3—FORM CONCRETE AND GUNITE COVERING OF VIADUCT STEELWORK

Curb and Railing—At each side of the roadway is provided a footwalk (shown in Fig. 3) about 2 ft. wide, intended for use by street cleaners, inspectors, police officers and other persons engaged on maintaining and guarding of the structure. To prevent cars which may be running out of control from leaving the roadway there is provided first an 8-in. curb between roadway and footwalk, and second a 12-in. curb at the outside of the footwalk. The latter curb forms part of the railing. Details of the railing are given in Fig. 4. The rail is of reinforced concrete. It will be seen that not only the railing posts but also each vertical member of the railing is securely fastened by steel rods to the structure. The purpose of the double curb and the heavy railing construction is effectively to prevent a car falling off the highway structure.

Expansion joints for the top rail of the railing are provided at each post as well as at the expansion joints of the structure. The expansion joints at the posts are formed simply by letting the top rail enter into a recess

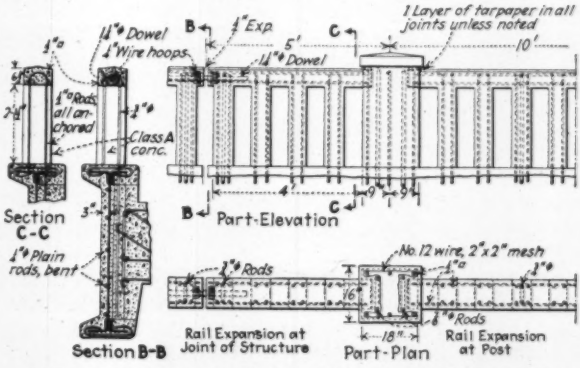


FIG. 4—RAILING CONSTRUCTION AND ANCHORAGE

in the post, having the same shape as the top rail and deep enough to permit expansion. The concrete of the rail and post is separated by means of a layer of tar paper. The expansion joints of the top rail at the expansion joints of the structure are formed by interrupting the rail. To maintain proper alignment a steel dowel is inserted at the joint. This dowel is free to slide at the one side of the joint and (in order to protect the steel dowel from rusting and the concrete from being discolored by rust stain) is covered with a brass sleeve at the opening. The purpose of providing expansion joints as described is to prevent cracking of the concrete of the railing, which is exposed to greater temperature damages than the remaining part of the structure.

The highway, when completed, will extend from the Holland Tunnel Plaza through Jersey Ciy, Newark and Elizabeth, and for the greater part of its length will be an elevated structure without grade crossings. Several sections of this highway are now under construction.

The work is being done by the New Jersey State Highway Commission and Major W. G. Sloan, state highway engineer. It is under the direct supervision of F. Lavis, with S. Johannesson as engineer of design and R. M. Beck as field engineer.

Unification of Rapid-Transit Lines Proposed in London

THAT effective relief of the congested traffic situation in London can be obtained only by unit management and control (not ownership), so as to replace a badly organized and competitive group of lines by a single comprehensive system, is the conclusion of a report made by an advisory committee to the British Ministry of Transport. A summary of the conclusions of the report is given below.

The proposal includes the setting up of a common management and a common fund to which all the passenger transport undertakings in London, including the underground and other local railways, the tramways and omnibus undertakings, would be parties. The Board of Management would be responsible to an authority which would settle questions of policy, determine broadly the form and nature of the facilities to be provided, settle the principles upon which fares would be charged upon each form of transport, and generally exercise financial control. A common fund means that, while the undertakings earn the most they can, they should share their gains and spread their losses on some equitable plan over all the undertakings, so that all enjoy an equal measure of prosperity. The governing principle is that each undertaking should earn according to its ability, but receive according to its needs.

There would be no disturbance in the ownership of the existing undertakings, and their officials who would constitute the Board of Management for operating purposes would therefore have a dual responsibility: to the owners of their undertakings and to the over-riding authority. Under this proposal all the existing forms of transport would be co-ordinated and the present uneconomic and wasteful competition could be eliminated, while it would be practicable to give the public more efficient service than at present. As to whether the suburban services of the four "main line" railways should be parties to this scheme, the evidence was not sufficient to allow of definite conclusions. This matter will require further consideration.

The proposal is based on the premise that, given such co-ordination, there is in London sufficient traffic not only to provide a satisfactory return on the large amount of capital already invested in transport undertakings, but to provide also a margin of income which would enable a steady and continuous policy of development to be pursued.

Finally, the committee added that the evidence submitted strengthens the view that no lasting solution of the London passenger transport problem can be secured so long as the present competitive methods are pursued. It is only by the elimination of all wasteful, uneconomic and unnecessary competition between the various transport agencies that it will be possible for any considerable improvements to be effected, particularly in the way of the construction of new underground or surface railways. The proposals for the establishment of a common management and a common fund appear to present a possible solution of the whole problem of London passenger transport. The evidence upon which this report is based has convinced the committee that the unified management of the local passenger transport agencies, including underground and other local railways, tramways and omnibuses, would provide the only permanent solution of the whole problem of London passenger transport.

Reinforcing the Joints in a 7-Ft. Ocean Outfall Sewer

Leaking Joints of Concrete Outfall Pipe at Los Angeles Calked Inside and Banded with Concrete Outside—Novel Methods in Work Done Outshore on Exposed Coast

THE HYPERION outfall sewer is a concrete pipe with an internal diameter of 7 ft., built some 5,000 ft. into the Pacific Ocean as the main discharge for screened sewage from the city of Los Angeles. Construction was completed in 1925 and was described in *Engineering News-Record*, Aug. 21, 1924, p. 296 and Aug. 20, 1925, p. 292. Soon after the outfall was put in service, sewage appeared on the surface at several points. Without taking the line out of service these leaks were repaired by submarine divers and the outfall then operated satisfactorily. About three months later leaks again appeared, as indicated by sewage rising to the surface and attracting sea gulls. Examination by divers indicated settlement in the outfall but the leaks were reported to be only in the top of the pipe, which was not considered dangerous. The important question was whether the pipe was still settling or whether it had reached a stable resting place. (The 12-ft. sections weigh 20 tons each.) Decision was made to wait another three months meanwhile observing the action of the pipe. At the end of this period, six months after completion of the line, no material increase in the number of leaks was observed and it was decided to put concrete collars around joints that had settled. In addition to banding the settled joints, it was decided to calk joints on the inside with lead wool throughout the entire length of the outfall, thus providing a more substantial construction than the original design.

DIVER GOING DOWN WITH AIR DRILL

Only about 800 ft. of the outer end of the line and a short section in the breakers near shore remained to be reinforced when the work was visited by a representative of this journal in January, 1927. The portion on which work was finished appeared tight after having been subjected to the test of several heavy storms and two earthquake shocks. With completion of work on the outer end the final step will be to build a trestle close inshore, where breakers make it impracticable to carry on diving operations from a barge, and to carry on similar repair work from this trestle.

During the progress of the work numerous improvements in methods have been developed and costs per joint have been reduced to one-fifth the initial figure.

When this outfall pipe was laid there was but little precedent as a guide. The size and weight of the sections and the fact that they had to be placed in the open sea subject to ocean storm conditions introduced problems not met in more sheltered work. The type of joint used was practically the same as the one reported to be giving satisfactory service on the multiple distributor in New York Bay leading from the uptake shaft of the Passaic Valley outfall sewer tunnel. There is no charge that there was any error in design or laxity in construction; Los Angeles authorities take the view, rather, that a new problem had to be worked out and, as a whole, has been solved satisfactorily. The extra work incidental to subsequent reinforcing of all joints has added about 30 per cent to the original estimate but the total cost is still much lower than for the metal pipe originally considered as an alternative.

Put in more specific terms, the original contract for concrete pipe was $687,434 as compared with $1,202,000 as the lowest bid for bell-and-spigot cast-iron pipe. The cost of reconstructing the joints, amounting to $204,476, will bring the total to $891,910. Even including this costly submarine work, the city points to a large saving in favor of concrete. This saving would be increased to over $500,000, it is pointed out, if allowance were made for commensurate damage to joints in a metal pipe line laid under the same conditions. The cost of joint reconstruction has averaged $8,000 per month with an average of 18 joints per month or $444 per joint.

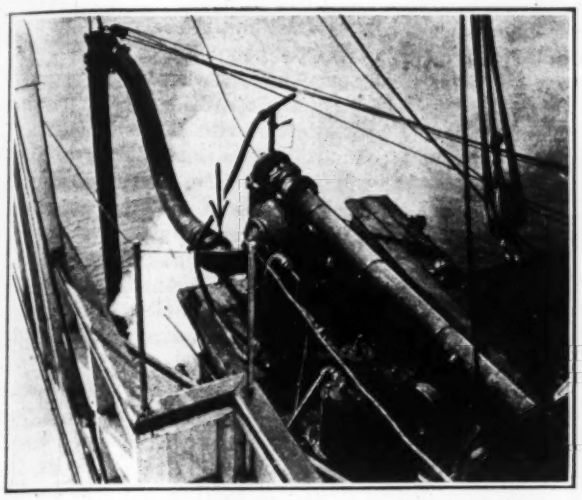
By the time the Hyperion outfall was ready for service existing sewers were badly overloaded and the new outfall was pressed into service on the day construction was finished. In fact, the urgent necessity for relief from overflowing sewers was a factor favoring the selection of concrete instead of cast-iron pipe which would have had to be cast in the East to order, involving considerable delay.

After the observation of leaks for the six months period and when the situation had been studied thoroughly it was decided that the mastic used in the joints was being pressed out, destroying the continuity of the line and allowing some of the individual pipe sections to shift and settle.

This joint weakness was a surprise. A joint test had been made on land during the construction period between two sections that were connected up with a standard joint. The ends were bulkheaded and a water pressure of 10 lb. per sq.in. put on. Under this test the joint showed no leakage.

Just why the mastic came out after the pipe had been put in service has not been definitely established but various theories are offered. Tectonic movements, it is suggested, may have been partly responsible, and a trench bottom of variable formation with irregular settlement is also suggested. However, the fact that some of the worst leaks occurred in the portion of the outfall supported on pile trestle is not explained on these theories. (The pile trestle support was put in only so far as the surf made it practicable to operate a piledriver.)

Another suggested factor is the reversal of pressure in the outfall that is continuously going on because, with the present volume of sewage, the hydraulic gradient cuts between crest and trough of waves. This causes a



SUCTION PUMP THAT EXCAVATES FOR OUTFALL SEWER COLLARS

Arrow indicates location of hand hole convenient for removing obstructions. Note steam ejector pipe connected with elbow above pump used in priming. An 8-in. pump is used.

water hammer or water ram effect inside the pipe whereby the pressure is greatly increased for an instant and then relieved altogether. Divers reported that for an instant water would gush from a leaky joint with such force that the hand could not be held over the leak. The pressure would then reverse and a current would be sucked in through the leaky joint with equal violence. After a slight settlement had caused a small leak this pumping action would doubtless have a very destructive effect, carrying out more and more of the filler.

The comparatively high temperature of the sewage causing a softening of the mastic is suggested as the preliminary to failure of the joint filler. This theory is supported by the fact that even where there has been no movement between adjoining pipe sections, streamers of the mastic thrust bodily outward from the joints were found floating, one end still fastened to the joint.

When the work of reinforcing the joints was getting under way on an extensive basis, progress was of necessity slow until the best methods could be developed. At first the divers drove wooden wedges from the outside into joints that had opened due to settlement. Then, when the leak had been stopped, grout was pumped under the outfall and the collar thus started was carried on up around the pipe by sacks placed over the joint with one side of the sack cut so the concrete would adhere to the pipe. A drawback to this plan was that unless the wedging was very thoroughly done a small leak would work through the green concrete before it could set.

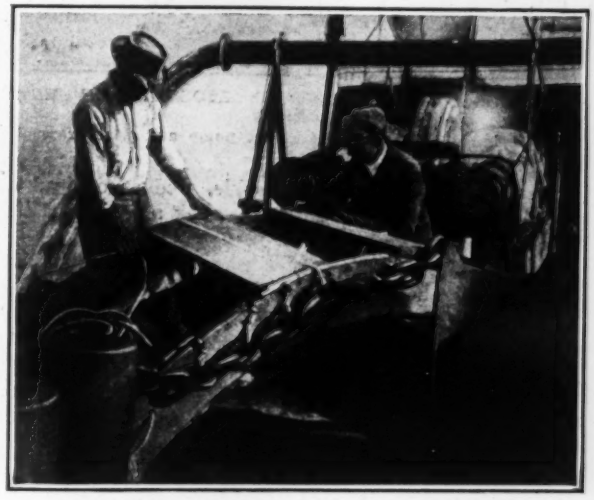
To avoid this danger and to do away with the need for dredging bell holes in which divers could work on leaks in the lower part of the joint, it was decided to do first a thorough lead wool calking job on the inside after which an external collar could be placed more conveniently and with greater assurance of permanence.

The next problem was that of making holes in the outfall through which divers could get in to work on the joints inside. No manholes had been provided in the submarine portion of the outfall. The first hole broken out required two weeks' work by divers operating air hammers. In contrast to this a manhole is now cut through cleanly by one diver in four hours.

The improved method of cutting manholes, which are 20x30-in. openings at the top of the outfall, consists in outlining the opening with drill holes and then shooting 4 sticks of 40 per cent dynamite placed on top of the slab to be removed. Using a Cochise air hammer and a 6-point bit on ¾-in. drill steel, 56 holes are required for the opening mentioned when placed as close together as practicable. Several air hammers were tried out and the success of the one mentioned on work of this type is attributed to an extra clearance of 0.001 in. around the piston and movement of valve; it is operated under an air pressure of 120 lb. at the surface. In addition to the holes marking the outline, two transverse rows of holes are put in, dividing the rectangle into thirds.

The manholes were made 300 ft. apart where the water depths were less than 45 ft. In depths beyond 50 ft. it was found more economical to space them 240 ft. apart. For work in depths of 50 ft. or more the divers got a bonus of $7 per day; they also got a bonus of $2 per day for each hundred feet beyond 200 ft. they had to go into the pipe to their work. The maximum distance that divers were worked inside the pipe was 380 ft., although divers went in further for inspection. Working some distance inside the pipe required the aid of a diver helper who went in halfway to carry lines and equipment.

The manhole openings blasted in the pipe were made



SEGMENTAL FORM SECTION READY TO GO DOWN

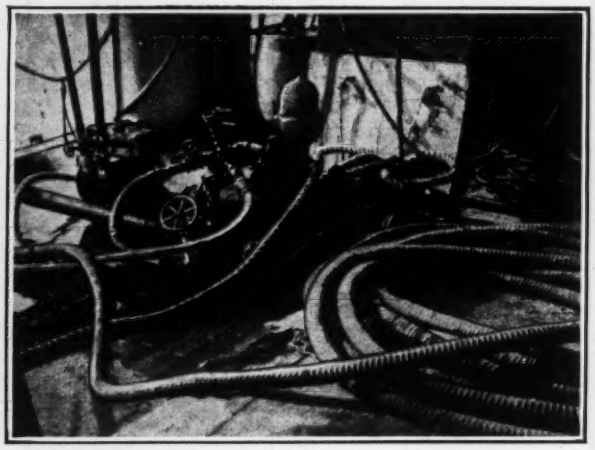
Chain used to sink form. Rope fastenings to be cut by diver. Diver nails on missing boards as filling with concrete progresses. Note suction discharge in background.

rectangular so that they could be conveniently closed by a steel plate curved to fit the outfall pipe and slipped endwise into the opening. This plate was then clamped in place by one or two toggle bolts passing up through steel bars placed across the top of the pipe. The steel plates were made tight by a gasket of oakum in a 4-in. roll, seized with burlap. These same steel plates were later used as inside forms for pouring concrete that permanently sealed up the openings.

The temperature inside the outfall is much above ocean water temperatures due to the warm sewage, and divers found that heat extremely uncomfortable for long continued work under air pressure. As a result most of the work inside the outfall was carried on during hours when the sewage flow was at a minimum and could be diverted into the old outfall adjoining and reservoired

behind gates in the main trunk sewers. The large capacity of the trunk sewers is thus serving as storage during the 5 hr. of the day in which two divers complete a 4-hr. shift. The stored sewage is released and is free to flow out during the remainder of the day.

Examination of the outfall by divers showed that the mastic had come out of joints and that in some places the pipe sections had moved and settled out of both line and grade. The maximum separation reported was 5 in. and in some cases there had been breakage at the joint due to unequal settlement of the heavy sections. Where breakage of spigot or sleeve had occurred and calking



PUMP USED FOR JETTING AND ALSO FOR DELIVERING GROUT

Note 2½-in. delivery connection at pump and wire-wrapped steam hose in foreground.

with lead wool was impracticable, wedges of lead or wood were first driven into the crack after which the interior calking was done.

The lower half of the pipe was the more important because leaks here tended to disturb the foundation and cause further settling. The lead wool was calked into placed on one-half the circumference at a time. Under ordinary conditions it took one 4-hr. shift for a diver to clean out and calk each joint, using, on the average, about 100 lb. of lead. Ingersoll-Rand type N-1 chipping hammers were used by divers in calking and the thickness of the calking tool was varied to suit the width of the joint opening.

At first there was much difficulty with the lead used. Poorly stranded lead containing lumps and subject to fiber tangles caused waste and delay. Conditions were much improved when a better grade of lead wool in the form of rope about ¾ in. in diameter was purchased. This material was strandable and had high tensile strength when twisted or tightly packed but when the strands were loosened and separated the rope could easily be pulled apart with the hands. This better grade cost no more than the unsatisfactory quality. Internal calking with lead wool was considered sufficient for most of the joints but in one joint in five, on an average, either disalignment or breakage at the joint made it advisable to use an external collar to strengthen and reinforce the pipe so that the wool calking may be expected to remain.

Where external collars are to be placed the first operation is to make a suitable excavation and force grout down under the lower third of the pipe. With this as a base, the reinforced-concrete collar is built up around the upper two-thirds of the joint. The excavation is made with an 8-in. suction pump whose intake pipe comes down vertically over the spot where work is under way. For the most part, the operation of the suction pump is directed by the diver with the aid of a telephone. Suction is maintained by a steam-driven centrifugal pump and the discharge is from a horizontal pipe projecting over the opposite side of the steamer where the material discharged can be seen by the winchman. A close watch is necessary to maintain the desired elevation of the suction intake; the intent being to keep it where it can continually lift a suitable percentage of sand or mud. The delivery of clear water is an indication that the pipe should be lowered.

In the operation of the centrifugal pump it was found important to use an elbow of the pump intake equipped with a 4-in. hand hole whose cover was clamped down by wing nuts adapted to speedy removal. Through the access thus provided obstructions which frequently choke the pump can be removed in 2 to 3 minutes. This pump is primed by setting a wood plug in the end of the discharge line and then exhausting steam through a 2-in. siphon tapped into the top of the pump casing. The ejector effect of this arrangement is sufficient to suck up the water column.

Except for operations close inshore, where a barge was used, the pumps and other equipment serving the divers are located on a steamer fitted up for salvage work and held over the spot desired by 5 anchor lines. When the swells are heavy it is virtually impossible to operate the suction pump excavator to good advantage. All the other operations carried on from this boat are but slightly hampered by swells and it is chiefly the excavation that has been affected by storm delays.

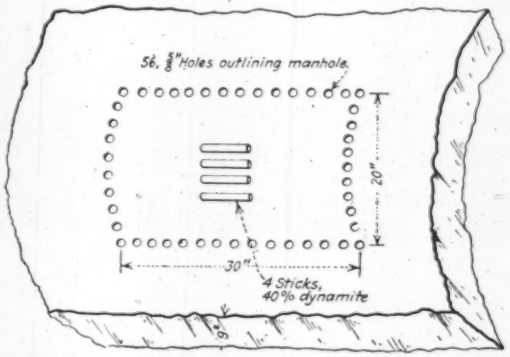
Excavation with the suction line is made on both sides of the joint about half way down to the original trench bottom. Then, before this pocket can fill up, a water jet is put down to loosen up the material still further down under the joint. This jet is worked successively from both sides by the diver. Immediately following this jetting, connections are changed on the steamer and grout is sent down through the same hose into the sand beneath this lower third of the joint.

CONCRETE PLANT ON STERN OF STEAMER

Note 4-in. suction line from pump to grout box beneath mixer. Man in right foreground is holding 2-in. pipe nozzle of jetting and grouting line.

The grout is made up in a 6-sack batch of 1:1½ mix. One such batch is put on each side of each joint. It has been found desirable to use sand of two grades in the proportion of one sack of beach sand to two sacks of screened sand of size graded to get the maximum density. The beach sand contains enough clay to make the grout flow well and prevent any tendency to clog in the pump and pipe.

In selecting equipment with which to do the grouting it was desirable to provide for delivery in large quantities under slow steady pressure. Neither the air placement method nor the small grout guns on the market



ARRANGEMENT OF DRILL HOLES FOR MAKING MANHOLE

were suitable. The equipment selected is a Cameron D pump of the type used in the oil fields for pumping clay. This pump is steam-driven, has a 4-in. intake and a 2½-in. discharge; it operates under a steam pressure of 150 lb. per sq.in. and the discharge pressure is about 500 lb. per sq.in. It can put down a ½-cu.yd. batch in 5 min. without pulsation or danger of violent or explosive deliveries that would disturb side slopes in the carefully excavated pockets under the joints. The drawback is that the steel valves in a pump of this type are easily clogged by even small pebbles or lumps in the grout. For this reason the pump was not recommended for this service by the manufacturers. This objection, however, has been reduced to a minimum by using the greatest care in screening the sand. Sand is screened carefully before being sacked for shipment to the job and the grout is screened on its way from the mixer into the metal box whence it is taken by the suction line of the pump.

The pump has now been in service for about eighteen months with a very low repair cost. The grout is cleared from pump and hose by pumping clear water for a few minutes after grouting is finished, and ordinarily the pump is opened up, inspected and cleaned out after placing four batches.

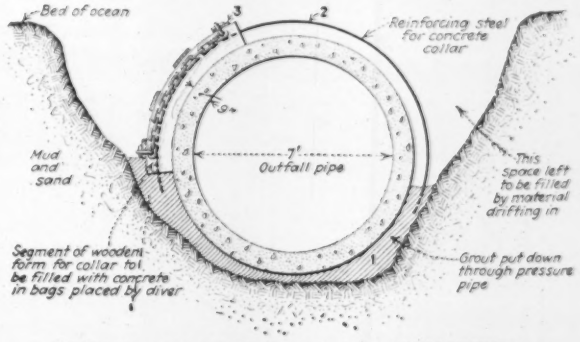
From the pump, delivery is through about 200 ft. of best quality 2-in. rubber steam hose, specially wrapped with No. 8 wire. This length of hose was found desirable to allow ample clearances and because it was more economical to provide leeway in extra hose length than to change the ship's position. For the convenience of the diver the grout hose terminates in a standard 2-in. iron pipe, 5 ft. long, which is used as a nozzle.

After thorough grouting under the lower third of the joint and while the grout is still fresh, the ends of a pair of ⅝-in. reinforcing bars, bent into a curve that will fit over the outfall, are thrust into the grout on both sides. These rods thus extend around the upper two-thirds of the pipe like hoops, from 3 to 6 in. from the surface of the concrete pipe. The diver then puts on and wires to these circumferential rods, horizontal rods 12 in. c. to c. Over this steelwork are put wood forms, 3 to 4 ft. wide, according to the kind of opening to be reinforced, which are made up in arcs of one-third or one-fourth the circumference.

The sides of the forms are laminated, being built up of 1-in. boards to fit the pipe curve. They have on their curved or under side several layers of burlap folded and tacked into place to form a cushion to fit the form tightly against the concrete of the pipe. Some of the cover boards are omitted so the concrete can be readily placed inside by the diver. The forms go down to the river weighted with enough chain to make them sink readily, and also to help hold them against the pipe while the concrete is setting. Later the chains are cut loose by the diver and hoisted to be used again.

The concrete, a dry mix with fresh water, is lowered to the diver in large sugar bags; the diver places these bottom up in the form and then carefully lifts off the bag, disturbing the concrete in the form as little as possible. These bags are only about two-thirds filled so that the top affords a good hand hold for the convenience of the diver in dragging the concrete along the bottom where this may be necessary.

The compressor equipment on the steamer consists of one Navy-type heavy-duty compressor with automatic control governed by a predetermined pressure in the main receiver, usually set at 120 lb. From this receiver supply lines go to the pneumatic equipment both on the boat and for use under water. A second air receiver fed from the first through a reducing valve is kept at about 80 lb. and this is again passed through a reducing valve to a 40-lb. tank that supplies the diver direct. With this combination, each step of which is trapped to


Bed of ocean
3
2
Reinforcing steel for concrete collar
9"
7'
Outfall pipe
Mud and sand
This space left to be filled by material drifting in
Segment of wooden form for collar to be filled with concrete in bags placed by diver
1
Grout put down through pressure pipe

SECTION, SEQUENCE OF COLLAR OPERATIONS

prevent the escape of air except in the direction toward the diver, the danger of any interruption of the diver's air line is minimized.

The early part of the work was under the direction of H. A. Van Norman, then city engineer of Los Angeles. He was later succeeded by John C. Shaw, the present city engineer. W. H. Pinkham is office engineer and F. A. Beatty is construction engineer of the north outfall sewer division which includes the Hyperion job. C. L. Cooke is diving inspector for the city.

The Merritt-Chapman & Scott Corporation held the original contract for the construction of the Hyperion outfall and its staff and equipment are carrying on the reinforcing of the joints on a cost-plus basis. G. L. Skolfield is general manager and chief engineer for the contractor and H. H. Hull is resident engineer on the Hyperion contract.

Board Reports on Los Angeles Flood Control Projects

Approves Forks Dam Site on San Gabriel River for 180,000 Acre-Ft. for Flood Control and Conservation—District's Policy "Not Based on Sound Engineering Principles"

THE Los Angeles County, California, supervisors late in December appointed three engineers, F. H. Fowler, C. D. Marx and Charles H. Paul, as a board of consulting engineers "to make a complete investigation and study and report of all phases of the flood control district's plan for the control and conservation of flood waters of the San Gabriel River." The board convened in Los Angeles on Jan. 10, reviewed all available data, visited the dams and the dam sites, had additional test borings made at the Granite Dike site, which was the site under consideration as an alternative for the Forks site, and on March 21 handed their report to the supervisors. Reference in the original instructions to "the San Gabriel River" was construed by the board to include tributary streams and hence, in addition to reporting on the proposed large dam in San Gabriel canyon, the board reviewed six smaller structures proposed, built or under way in the basin tributary to the San Gabriel River. A general review of the Los Angeles flood control situation as a whole appeared in *Engineering News-Record*, June 3, 1926, p. 890, and a news note about the recent report was published March 24, 1927, p. 501. The following is a summary of the findings in the report.

The drainage basin above the mouth of the San Gabriel canyon includes 222 sq. miles and runoff records are available for a period of 31 years with estimates based on rainfall records going back 76 years. The records show a marked tendency to long cycles of wet and dry years and a very wide variation in flow, the runoff for the minimum year (9,630 acre-ft.), being only 2.5 per cent of the highest year of actual record (410,000 acre-ft.). The mean seasonal runoff for 31 years is 121,400 acre-ft.

"To the casual observer it would appear that all of the water might be conserved from these occasional high years by building large reservoirs to give a cheap and dependable supply during succeeding years of drought. This is not the case; rare occurrence of these unusual runoffs, excessive evaporation losses during long holdovers that follow, and high unit cost of reservoir capacity 'defeat such a program.'" During the period succeeding 1890, holdover storage to maintain the long term mean of 121,400 acre-ft. would have required storage for 14 years, during which time much of the supply would have been lost by evaporation alone. "On the San Gabriel, cost of holdover storage is tremendously high and is not warranted."

The high storage cost makes it impracticable to build separate dams for conservation and flood control, and therefore safety requires that the storage space allotted to each use be clearly defined and definitely separated. The required conservation capacity is allotted to the bottom of the reservoir and permanently open flood outlets are placed at the upper limits of this storage space. A conservation storage of 70,000 acre-ft. was found to be the maximum that could be spread economically—surface storage was not considered practicable. A flow of 1,000 sec.-ft. is the maximum rate at which water can be absorbed when spread on the gravels at the mouth of the canyon.

In view of the tendency of the San Gabriel to long cyclic periods and because the runoff records go back only 31 years, factors other than these records were taken into account in assuming a maximum flood. This was estimated on the basis of 350 sec.-ft. per square mile of drainage basin and gave a peak flow at the canyon mouth of 77,500 sec.-ft. The hydrograph of the maximum flood assumed by the board follows the shape of the largest flood on record (1916) but with the hour-by-hour flow increased 94 per cent. The maximum permissible regulated flood flow at the mouth of the canyon was fixed at 20,000 sec.-ft.

Taking the cost per acre-foot of the reservoir capacity and the percentage of years in which such storage capacity can be utilized, the cost per acre-foot of *usable* conservation storage for the 70,000 acre-ft. capacity approaches the limiting price per acre-foot of annual yield that can be paid for irrigation water in southern California.

Conclusions

In the following conclusions, the Consulting Board is unanimous:

1. **That on the San Gabriel project, long holdover storage is not economically feasible.**
2. **That the storage capacity devoted to flood control should be definitely separated from the storage capacity in the same reservoir devoted to conservation.**
3. **That the Granite Dike dam site is unsuited for a dam so high as to give the required storage capacity.**
4. **That a reservoir for flood control and conservation in the San Gabriel Canyon should be built for a total storage capacity of 180,000 acre-ft.**
5. **That this capacity should be allotted as follows:**
   5,000 acre-ft. for debris storage
   70,000 acre-ft. for conservation and spreading storage
   105,000 acre-ft. for flood control.
6. **That to give this required capacity, a dam approximately 385 ft. high from stream bed should be built at the Forks site.**
7. **That the cost of this dam and reservoir will be approximately $25,800,000.**
8. **That a dam at the same site storing 240,000 acre-ft. would be about 430 ft. high above stream bed, and, with the reservoir, would cost $31,000,000 or more.**
9. **That other units of the project, now built or contemplated, need careful replanning.**
   (a) The San Dimas dam is of no use for the control of large floods and the spillway should be enlarged.
   (b) The Puddingstone spillway should be enlarged.
   (c) The Big Santa Anita dam is of doubtful value.
   (d) The plans for the Big Dalton Creek and Thompson Creek dams need revision.
   (e) The proposed dams in Eaton Canyon and in Sawpit Canyon are not economically justified.
10. **That the Board of Supervisors has suffered from poor engineering advice as to a co-ordinated plan for the San Gabriel Flood Control Project.**

From $200,000 to $250,000 is recommended for check dams in the upper reaches of the San Gabriel tributaries. This recommendation is based on observation of the check dams placed in the higher portions of Haines canyon in 1915 which are still in good condition and doing effective work. Such dams must be started at the upper end of the small tributaries and should not be continued to the point where the dams become large and expensive structures. "Obviously the application of check dams is limited, but in so far as they are feasible they not only stop erosion and permit and encourage the growth of brush and other vegetation, but they definitely retard the flow and promote ground storage. The character of the flood discharge from Haines canyon has been entirely changed since the installation of these check dams in 1915."

In selecting the site for the large dam in San Gabriel canyon, it was noted that opinions of geologists showed little choice between the Granite Dike and the Forks sites, provided further examination of physicial characteristics showed satisfactory conditions. At the suggestion of the board that further investigation of the Granite Dike site was needed, some core drilling was done in the river bed, and four tunnels were driven into the west hillside, one near the bottom, one at spillway elevation, and two others about equally spaced between them. Three of the tunnels went into the hillside 100 ft. or more and the fourth 73 ft., without encountering rocks considered suitable for the abutment of a dam of the height contemplated. Construction at this site would be more difficult and expensive than had been contemplated and, all things considered, the Forks site was selected in preference to the Granite Dike site.

Storage Capacity—With the assumed maximum flood discharge of 77,500 sec.-ft. and the degree of control desired, it was found that the reservoir capacity necessary for flood control above that provided for conservation storage would be 105,000 acre-ft. Thus the total capacity recommended for the reservoir is: Debris storage, 5,000 acre-ft., conservation and spreading, 70,000 acre-ft., flood control, 105,000 acre-ft., total, 180,000 acre-ft. This calls for a dam at the Forks site, 385 ft. above the present stream bed or 450 ft. above foundation.

The design of the San Gabriel dam cross-section, known as the "R" section, as worked out by the Flood Control District, was approved by the board although for the larger reservoir as recommended by the Flood Control District "the spillway design . . . . is entirely inadequate and reasonable safety measures would require spillway protection of entirely different character and of much greater cost." The estimate made by the board of the cost for a dam to store 180,000 acre-ft. is given in the accompanying table (p. 572).

The board also estimated the cost of a dam that would store the 240,000 acre-ft. contemplated by the Flood Control District. Based on unit costs similar to those used in estimating the dam for an 180,000 acre-ft. reservoir, the cost of the 240,000 acre-ft. dam was estimated at $31,063,000, to which should be added the cost of a larger spillway if the flood control space in the reservoir were also used for conservation storage.

The latter portion of the report calls attention to urgent need for careful replanning of other units of the San Gabriel flood control project now in various stages of completion. "The board is convinced that ordinary engineering and economic principles have not been applied to the planning of the various units of the project in advance of their construction. The dams have been well designed structurally and are being well built, but the flood control capacity provided bears no relation to the maximum runoff to be expected from the drainage areas. The economics of conservation storage seems to have been ignored. There is no definite program for the operation of the dams except to let the basins fill whenever they will and then to take chances on handling the floods through the spillways. . . . the flood control feature of the project has been largely or wholly subordinated to the conservation feature and that the dams already built are being used almost solely for conservation and therefore are of practically no use for flood control."

Redesign—Decision should be made in advance whether a reservoir is to be used primarily for conservation or for flood control. This decision governs the capacity required, the size, location and type of outlet and type and capacity of spillway. "It is a direct violation of sound engineering to design for one purpose and assume that the structure will function for both."

The San Dimas dam is of no use in controlling large floods and because of limited spillway capacity and resultant danger of overtopping, might be a menace to property below. To make it safe a large increase in spillway capacity is required and a flood channel should be provided down the San Dimas wash.

The Puddingstone earth fill dam, in addition to the runoff from its own 36-sq. mile drainage area, is to receive surplus from the San Dimas reservoir through a diversion canal. The Puddingstone dam, however, is in danger of overtopping even without considering the flow to be brought in from another basin. A redesign of the spillway is imperatively necessary and without it the dam will not be safe.

The Santa Anita dam with a drainage area of 11 sq. miles and a storage capacity of 1,530 acre-ft. has an outlet and spillway capacity of 3,870 sec.-ft. This structure would have only negligible effect on floods of size less than those used in defending the large storage capacity which the district proposes for San Gabriel River. "The Big Santa Anita dam cost over $1,000,000. It is of doubtful value for conservation and is of no value for flood control, except for smoothing out peaks of small floods."

The Big Dalton dam, with a drainage area of 5 sq. miles, has a storage capacity of 1,300 acre-ft. and a total outlet capacity of 1,300 sec.-ft. The periods of many consecutive years when this dam would have practically no water to store make it of doubtful economic value for conservation storage and to be adequate for flood control it should be able to handle a maximum daily runoff of at least 4,000 acre-ft. Thus this structure estimated to cost $600,000 is of no practical value and "without a larger spillway than is now contemplated this dam is considered to be positively unsafe."

Sawpit and Eaton Canyon dams have adequate outlets and spillway capacities but both are very expensive per acre-foot of storage and their slight value for either conservation or flood control is "not enough, in our judgment, to justify their high cost."

The proposed Thompson Creek dam with a drainage area of 3 sq. miles, a reservoir capacity of 1,025 acre-ft. and combined outlet and spillway capacity of 325 sec.-ft. needs a revision of plan to avoid danger of overtopping.

A maximum daily discharge of 2,500 sec.-ft. may be expected from this drainage area.

In all of these studies on the smaller drainage areas maximum peak discharges are estimated on the basis of 400 sec.-ft. per square mile for areas of 25 to 40 sq. miles, and 600 sec.-ft. per square mile for the areas of 3 to 5 square miles. "There is ample justification for such assumption. Already there is a record of 367 sec.-ft. per square mile from Eaton Canyon drainage area. If figures were to be accepted as large as those suggested by the chief engineer of the Flood Control District in some of his communications, the inconsistency of the plans for many of these storage units would be all the more noticeable."

ITEMIZED COST ESTIMATE FOR DAM AT FORKS SITE
(For reservoir of 180,000 acre-ft. capacity)

Preliminary expense	$350,000	
Land and right-of-way, 450 acres at $400	180,000	
Engineering and supervision	450,000	
Railroad construction, 12 mi. at $55,000	660,000	
Power lines, telephones, etc.	75,000	
Contingencies	550,000	$2,265,000
Clearing reservoir (lower part only)		50,000
Cement, 2,800,000 bbl. at $2.18 net		6,104,000
Stream control	$125,000	
Excavation:		
400,000 cu.yd. at $1.50	$600,000	
550,000 cu.yd. at 2.50	1,375,000	
55,000 cu.yd. at 10.00	550,000	2,525,000
Spillway excavation	300,000	
Concrete, 3,100,000 cu.yd. at $2.40* (not including cement and plant charges)	7,440,000	
Spillway concrete, copings, etc.	250,000	
Grouting, drainage, inspection galleries, contracting, joint details	250,000	
Outlet works, gates, trash racks, etc.	180,000	
Construction plant (less salvage)	1,800,000	
Upkeep and maintenance	675,000	
Railroad operation, 60 mo. at $4,800	288,000	
Camp, warehouses, terminals, water	300,000	
Camp maintenance (net loss)	80,000	
Contractor's general expense, including superintendence, clerical, engineering, miscellaneous operations and general overhead (3 per cent)	426,000	
Casualty and liability insurance	360,000	
Interest charges during construction (6 per cent on $3,500,000) for 3 yr. average	630,000	
Contractor's margin, including profit, flood risk, delays, contingencies (8 per cent)	1,250,000	
Surety bond	500,000	17,379,000
Total estimated cost		$25,798,000

	Per Cu.Yd. of Concrete
*Handling cement in and out of storage, loss on sacks, handling sacks, etc.	$0.20
Aggregates (2 tons per cu.yd.)	.85
Handling aggregates	.15
Mixing, distributing and placing	.65
Curing, cleaning, etc.	.05
Forms (1½ sq.ft. per cu.yd. at 20c. average)	.35
Miscellaneous	.15
Total (including power and fuel but exclusive of cement, plant charge and overhead)	$2.40

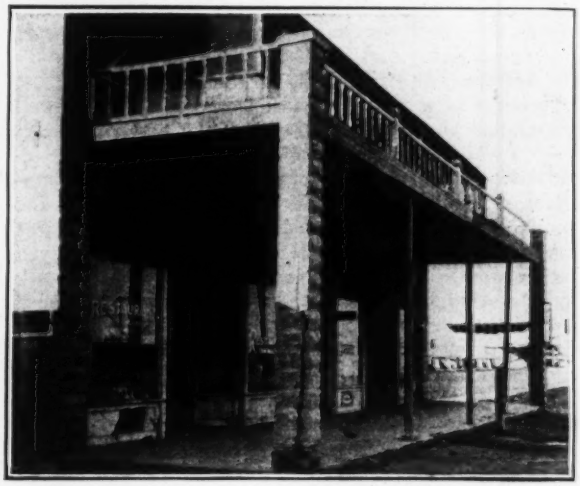
"The chief engineer has repeatedly announced as his policy that 'dams are proposed to the maximum height which I thought physical conditions offered for safe construction and of course these heights govern their capacities.' The general carrying out of the project to date squares up with that policy. It is not based on sound engineering principles and, as would be expected, it results in expenditures of doubtful value and in some structures, of doubtful safety."

The report concludes as follows: "The Board of Supervisors, in the opinion of the Consulting Board, has suffered from poor engineering advice as to a coordinated plan for the San Gabriel Flood Control Project. Large sums have been expended which, in our opinion, could have been used to much better advantage. By proper engineering and economic studies of future plans, before construction is undertaken, a repetition of such mistakes may be avoided."

Earthquake Damage to Buildings in Calexico and Mexicali

New-Years-Day Shocks Centering in Nearby Fault Cause Large Property Loss—All Types of Buildings Affected

EXTENSIVE structural damage was done in the cities of Calexico, Calif., and Mexicali, Mexico, by a severe earthquake on the morning of Jan. 1. A feature of the effect was damage to arcades or masonry porticoes built over the sidewalks. While the cities have only low buildings, all types of construction were affected; in every type well constructed buildings came through with little damage, and marked damage was generally traceable to faults of construction. The earthquake was of quite heavy character, being estimated by one observer as between VIII and IX on the Rossi-Forel scale. The following notes are taken from reports of personal observations made by Robert E. Andrews and J. E. Shield for the Board of Fire Underwriters of the Pacific, and A. C. Horner for the Portland Cement Association.



TYPICAL EARTHQUAKE DAMAGE
This is a brick building. The arcade was distorted and the walls were cracked and partly destroyed.

The two cities, which except for the international line dividing them are in effect one, with a total of some 18,000 inhabitants, suffered damage estimated in the neighborhood of $1,000,000. Buildings were generally two stories high, and therefore low enough to be sturdy; however, as the region is one of deep alluvial soil, both the intensity of ground movement and the relatively poor foundation conditions (ground permeated with irrigation water) tended to increase the severity of the earthquake effect.

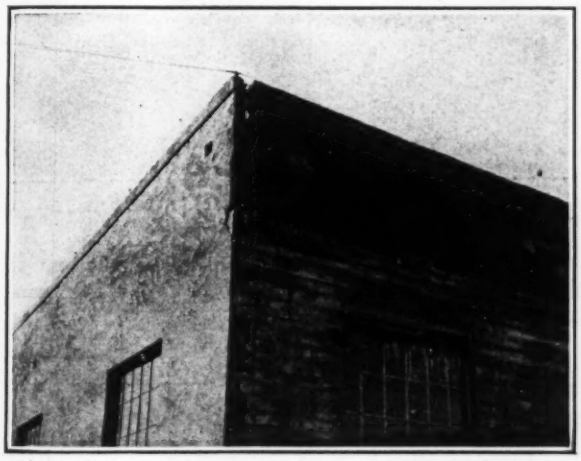
The first shock occurred shortly after midnight, Jan. 1, and a number of other severe movements followed during the next five hours; minor shocks continued for several days. Damage, however, was closely localized to the Calexico region, there being no noticeable damage beyond 10 miles away. The direction of movement seemed to be various. The San Jacinto fault, a branch of the San Andreas fault which extends through most of California, is said to pass 2 miles east of the city, and two others some 15 or 20 miles west. The former is believed to be the origin of the earthquake.

Public services were little damaged except for the electric supply. Wires came down extensively. In Calexico three small wrought-iron water mains and a dozen or so house services were broken, aside from large damage to the piping inside houses; but the larger cast-iron mains were not injured, and the pumps, tanks and buildings of the water-works were undamaged (the 90-ft. 50,000-gal. tank had several diagonal rods broken). Shaking the batteries of the Calexico fire-alarm system off the shelves and the collapse of a fire-house wall breaking one circuit put this system out of commission for nearly three days. Fires that occurred during the earthquake period were successfully handled, however.

Almost every business building in both cities was damaged. Brick-wall joisted structures predominated, but there is a number of reinforced-concrete buildings, both of skeleton and of integral construction. Smaller structures were quite generally of either adobe or frame, the former with walls 12 to 18 in. thick, bare or plastered. Hollow building units were not extensively used. About 95 per cent of the chimneys were damaged.

In brick buildings, walls both with and without reinforced-concrete belt courses above the windows suffered extensive cracking, bulging or partial overthrow. Two buildings, the high school and library in Calexico, which after the 1915 earthquake were strengthened by reinforced-concrete belt courses with outside buttresses to foundation level, were saved with relatively little damage by this reinforcement, though the school was subsequently condemned.

Adobe houses where of best construction resisted well,



DAMAGE TO AUTOMOBILE SALES ROOM AND GARAGE
Concrete building. One wall bowed out and the parapet split.

but a large number of poorly constructed adobe houses in Mexicali went down. Wood frame structures are reported to have shown excellent resistance. Reinforced-concrete buildings in general suffered only minor cracks, broken windows, and parapet wall breaks, but walls not adequately tied by floor and roof framing bulged out. The reinforced-concrete telephone building was much damaged, the north and south walls being cracked and one of them split away from east and west walls. Service was interrupted. Concrete skeleton buildings with filler walls of other materials had the filler panels displaced in a number of cases.

Mr. Horner, among his conclusions, states that more careful attention to tying together the walls of both masonry and concrete buildings is necessary. "Such ties should be sufficient both in tension and compression, and one anchor every 6 or 8 ft. is not always sufficient. The most common failure to provide ties of any kind appears to be in the case of walls paralleling roof joists or rafters."

Messrs. Andrews and Shield conclude, among other things, that "each community must depend on its own resources for at least several hours after an earthquake"; also, that automatic devices to cut off electric current from individual buildings in the event of an earthquake are far preferable to those cutting off current from an entire city, and will permit street lighting to be maintained.

Prior earthquakes in the Calexico region are said to have occurred Nov. 9, 1852 (severe), February, 1892, and June 22, 1915 (severe; about same intensity as 1927).

Forestry to Prevent Silting of Reservoirs

Careful estimates of the value of reforestation of reservoir drainage areas are presented by W. W. Ashe, of the U. S. Forest Service, in "Financial Limitations in the Employment of Forest Cover in Protecting Reservoirs" issued as Bulletin 1430 of the Department of Agriculture. The author shows that the productive return of the forest through timber sales will not be likely to pay for forestation unless the land can be bought at very low price. However, the prolongation of life of the reservoir represents a large item of value to be credited against reforestation. This value may be computed by determining the present value of the prolonged life of the reservoir. In a particular case, in the Piedmont region of the southeastern states, short-leaf pine planted as two-year-old stock would produce after forty years a yield of 17,100 board feet of saw timber and 18¾ cords of pulp wood, having a probable value of that time of $9.51 per 1,000 and $2 per cord, making a gross return of $200 per acre and a net of $158 after paying for taxes and protection during the forty years. The present value of this return is $12.50 (at 6½ per cent compounded). The cost of planting is set at $8, leaving only $4.50 per acre available for purchase of the land. However, a reservoir development costing $2,000,000 and silting so rapidly that it would lose three-fourths its storage capacity in forty years might be so protected by reforestation of denuded lands in its drainage area that only one-quarter of its capacity would be lost in forty years, and in that case the reforestation would produce savings (or prevent losses) whose present value is computed as $353,646, which sum is available for land purchase. In the West, streams having their sources in the Rocky Mountains drain areas with irregular but for the most part heavy rainfall. The headwaters of these streams are in forest regions. Wherever extensive areas have been denuded and exposed to concentrated rainfall, these streams have high turbidity during flood. If the forests have not been cleared from the headwaters or if the surface has not been denuded by fires erosion is slight and silting does not threaten the reservoirs, but if there is excessive erosion due to soil exposure it is possible to restore forest conditions and thus reduce erosion and lessen sedimentation in the reservoirs.

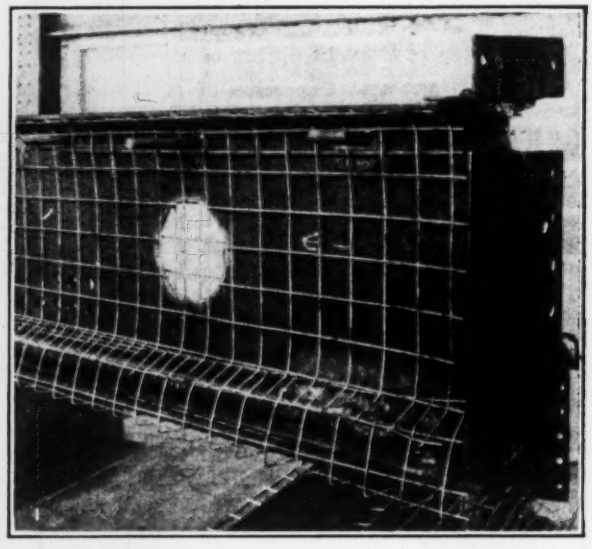
Tests of Corroded Steel Beams Restored with Gunite

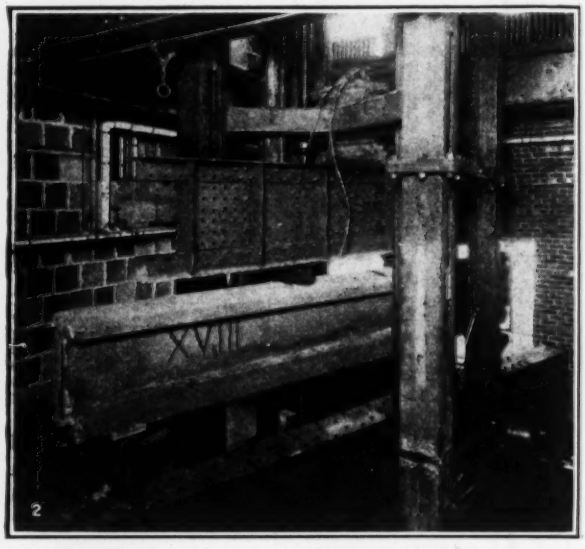
Beams with Plain and Reinforced Encasement Tested in Comparison with Bare Beams —Bond Found to Be Excellent

By J. R. Shank

Associate Professor of Structural Engineering, Ohio State University, Columbus

A NUMBER of tests were made at the Ohio State University engineering experiment station last spring on scrapped plate girders and I-beams encased with gunite, some with and others without reinforcing bars. The purpose was to determine whether a corroded steel beam could be reinforced sufficiently to restore it to its original new value. The tests were suggested by C. C. Cooke, of the Fritz-Rumer-Cooke Co., railroad construction contractors of Columbus, which company prepared the test beams and assisted in running the tests. The old beams were furnished by the Pennsylvania R.R. through J. F. Leonard, engineer of bridges, Pittsburgh. The tests were directed by the writer under the advice and with the co-operation of C. T. Morris, professor of structural engineering.





FIGS. 1 AND 2—CORRODED I-BEAM READY FOR GUNITE ENCASEMENT, AND ENCASED BEAM UNDER TEST
24-in. 80-lb. I-beam, reinforced to make up original bending strength; tested on 13-ft. span.

Test Beams—The steel beams were 21-in. plate girder stringers erected 1885, and 24-in. 80-lb. I-beams of a later date. The original moment of inertia of the plate girders was 1300.97 in.⁴ gross, or 1081.07 in.⁴ net, that of the I-beams 2087.2 in.⁴ gross.

Encasement was made by shooting ordinary gunite onto the steel, over 3x3-in., No. 8, electrically welded wire mesh. The gunite was built out to a thickness of 1½ to 2 in. One test was arranged to show the effect of encasement with no steel other than the mesh, and two others the effect of restoring the reduced section by reinforcement and concrete. The reinforcing steel was welded into the web or flange of the structural steel near the ends (Fig. 1).

Method of Testing—In testing, equal loads were applied at the third-points, bearing directly on the structural steel. Deflections were measured at midspan, top deformations on both gunite and steel, and bottom deformations on structural steel and reinforcing steel.

The moment of inertia of the corroded I-beam of Fig. 1 just before the test, computed from caliper measurements, was 1008.95 in.⁴, less than half of the original value. The combined section, Fig. 4, was reinforced to give the original strength. The design was not made by the writer.

Fig. 3 shows the load-deformation curves for this same I-beam together with theoretical curves, for comparison. The unit stresses are computed on the basis of $E = 30{,}000{,}000$ lb. per sq.in. The bottom readings were taken directly on the structural steel.

Eight scrapped beams were tested—four plate girders and four I-beams; one of each was bare, one encased with 2 in. of gunite (tested at 7 days), and two encased and reinforced. The reinforced plate girders were tested at 28 days; one, No. XI, had bars bent up at the ends as is done for shear reinforcing. The rein-

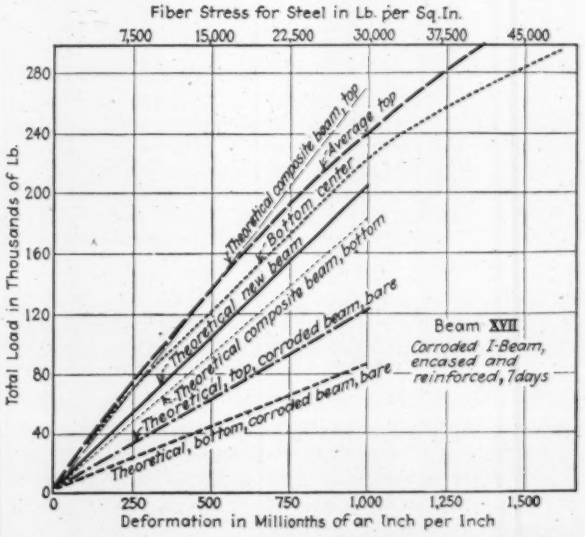


FIG. 3—COMPARATIVE STRESS CURVES, REINFORCED BEAM XVII

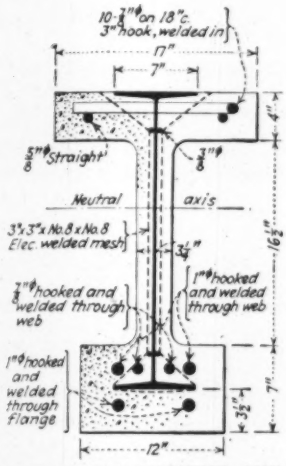


FIG. 4—ENCASEMENT AND REINFORCING STEEL BEAM XVII

Moment of inertia of encased beam, 2385.4 in.⁴; section modulus for compression, 246 in.³, for tension 166.8 in.³.

forced I-beams were tested at 7 and 28 days respectively. Two new Bethlehem I-beams were also tested, one bare and the other encased.

The adjoined table gives the results of the tests. The properties of the sections shown are for the beams as tested. For the gunited beams they are computed according to the straight-line principle, $n = 10$, no tension in gunite, and all steel including the mesh considered. A plot was made for each test as for beam XVII shown in Fig. 4, and from these curves were taken the values tabulated under "Observed load carried at 16,000 lb. per sq.in." All of the loads given are superimposed loads (excluding weight of test beam).

The table does not show the computed load capacity at 16,000 lb. per sq.in. for the original unreduced plate girders and I-beams. These values for the plate girders are 65,000 lb. in tension and 70,800 lb. in compression, and for the I-beams 105,700 lb. for both flanges. It will be noticed that all of the reinforced encased beams carried loads well over these values and in only a few cases did they carry less than those calculated more rigidly on the cross-section as used. The variations from the calculated values are in general less than those from the calipered values of the bare steel beams. The observed values for the bare beams are greater than the calculated ones, particularly for the I-beam; this is not strange, for an inspector will naturally have his eye on bad spots and his measurements will very likely bear towards these.

The tension flanges seem to do better all along than the compression. There may be two reasons for this; that considerable tension was taken by the gunite, and that the value of 10 for the ratio of the moduli of elasticities was too low.

Cracks began to appear at steel unit stresses of from 8,000 to 16,000 lb. Cracks were made early visible by whitewashing the sides of the test beams.

The bare plate girder XII failed by lateral buckling

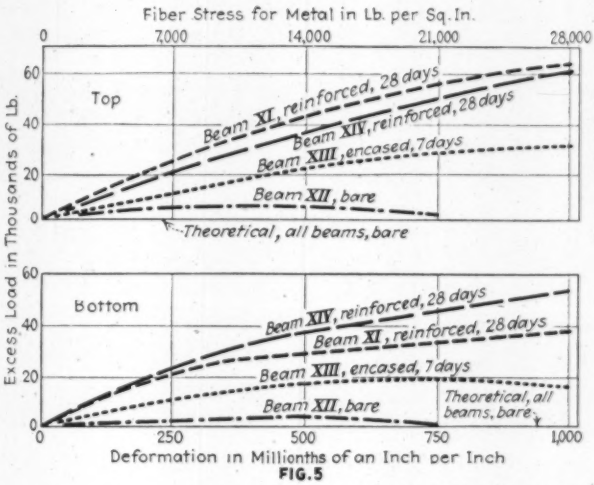


FIG. 5

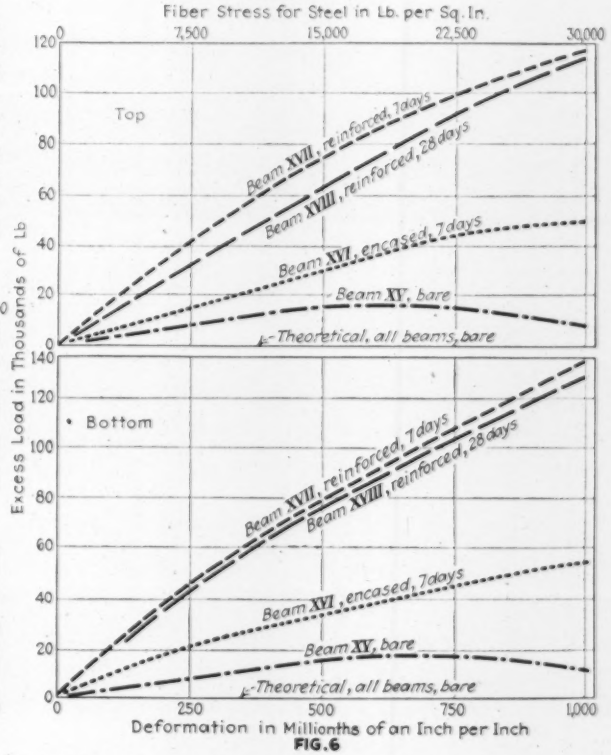


FIG. 6

FIGS. 5 and 6—EXCESS-STRENGTH CURVES FOR I-BEAMS AND PLATE GIRDERS

TABULATION OF WORKING AND ULTIMATE LOAD DATA

Member	Test Span In.	Ft.	Type and Age at Testing Days	Moment of Inertia	Section Moduli Tension	Comp.	Observed Loads Carried at 16,000 Lb. per Sq.In. on Metal Tension	Comp.	Loads Computed from Section Moduli 16,000 Lb. per Sq.In. on Metal Tension	Comp.	Difference in Per Cent of Computed Load Values Tension	Comp.	Ultimate Load	In Per Cent of Obs. Load at 16,000 Per Cent Tension
Plate Girders														
XII	12	0	Bare—	890.8	80.4	89.8	60,000	66,500	52,400	58,600	+13	+12	84,300	140
XIII	12	0	Plain-7	975.8	75.8	120.3	65,000	76,000	48,000	77,500	+35	—2	164,300	253
XIV	12	0	Reinf.-28	1,385.5	111.7	161.1	95,000	101,000	72,000	104,700	+32	—4	225,700	237
XI	12	0	Reinf.-28	1,302.7	103.4	154.8	80,000	104,000	66,200	100,200	+21	+4	227,950	285
I-Beams														
XV	13	0	Bare—	2,087.2	79.9	105.2	68,000	85,000	48,100	63,700	+29	+25	146,825	216
XVI	13	0	Plain-7	1,107.2	67.2	146.4	73,000	90,000	38,800	87,900	+88	+2	Local Failure	228
XVIII	13	0	Reinf.-28	2,385.4	176.8	241.5	136,000	135,000	104,900	144,800	+30	—7	Local Failure	186
XVII	13	0	Reinf.-7	2,453.7	166.8	246.0	129,000	145,000	99,000	147,600	+30	—2	328,300	254
Beth.														
I-Beams—A	19	0	Bare—	1,629.3	147.7	147.7	62,000	59,000	60,800	60,800	+2	—3	140,850	227
—B	19	0	Plain-29	2,190.5	157.6	206.3	66,400	.....	62,700	.....	+7	....	222,050	335

of the top flange followed by a sudden buckling of the web, most marked at one end. There were no stiffeners on the ends. In setting up the test for beam XVI a large cast-iron block was used to distribute the load to the loading girder; this block broke at 166,200-lb. load, suddenly releasing the load on the test beam, and the beam would take no further load after this. The stress-strain curves indicated that the test beam was very close to failure before the casting broke. Beam XVIII failed by the bearing block at one of the loading points crushing into the flange of the I-beam, breaking out the side of the T head which reinforced the corroded top flange. The others of the encased beams failed by a general vertical deflection with the top flange bowing somewhat to one side. Cracks in the bottom were very close together and small, no one crack opening wide. They generally took a direction at right angles to the resultant tensile stress.

The stiffening effect of the encasement is clearly shown in the amount of load taken above that which produced 16,000 lb. per sq.in. in the tension steel (see last column of table). Comparison of beams A and B shows this particularly.

Figs. 5 and 6 summarize the curves for all the tests. They show the excess-load curve for each test beam in comparison with that of its own theoretical bare corroded beam as computed from the caliper notes.

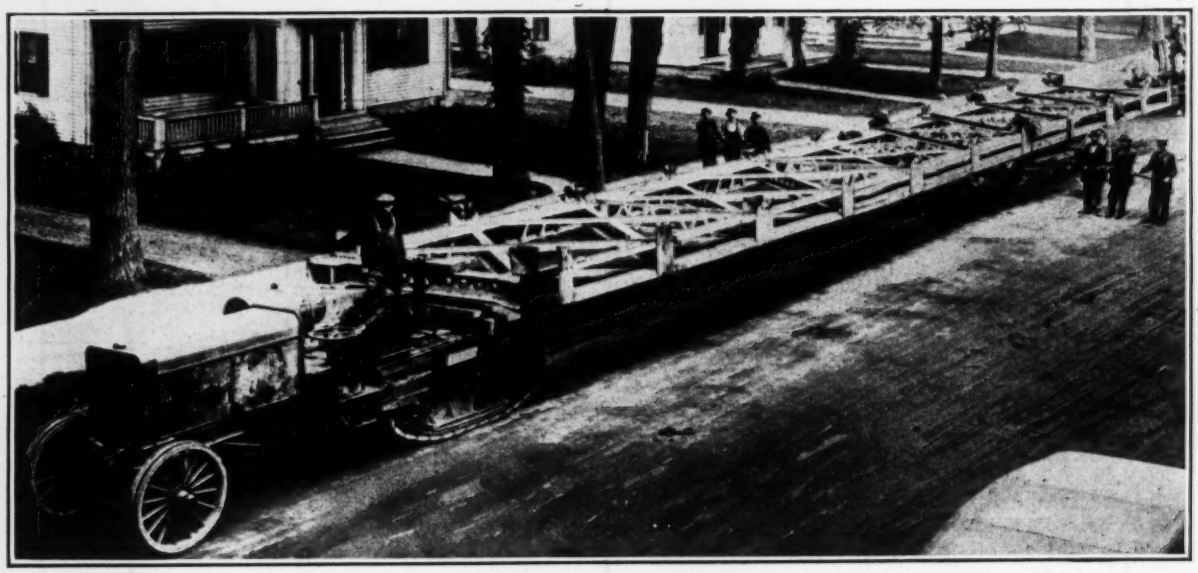
While noting the proportionate increase of the loading values of these encased beams, it must not be lost sight of that the gunite, being a portland cement concrete, has a plastic flow property. This plastic flow would tend after some time to shift somewhat more of the load onto the structural steel than these tests indicate.

Bond—The bonding of the gunite to the steel was good in all tests even up to very high loads. In some cases where the reinforcing was heavy, the loads carried were more than 100 per cent of that which theory would indicate for the bare beam. Beam XVII at 7 days showed an increase, at 16,000 lb. per sq.in., of 118 per cent at the top and 172 per cent at the bottom over that computed for the bare unencased beam; and at the same time exceeded that computed for the composite beam by 30 per cent on the top and showed a deficiency of only 2 per cent at the bottom. The final cracking of the gunite indicated also a good bonding. In some cases there was noticed a slight marking of the gunite at the end where the structural steel protruded, which appeared to indicate a loosening of the bond, but this did not seem to affect the test in any way. In attempting to remove gunite from the steel it was found that rapping the steel did not avail to loosen the gunite. It was necessary to wedge it off and then finish by chipping as the piece wedged off more often broke in the gunite than between the gunite and the steel.

Conclusion—The principal question that was asked in making of these tests was whether the gunite with its reinforcement would bond sufficiently with the steel to cause the structural steel and the reinforced gunite to act as a unit. This question was answered in the affirmative.

Eighteen-Ton Trusses Hauled Two Miles by Tractor

IN BUILDING a bridge across one of the feeders from the river to its power plant the Lockwood company, owners of a large cotton mill on the Kennebec River at Waterville, Maine, was confronted with rather limited erection space. A contract was let to the Saunders Engineering Co. to build the bridge. That company assembled the trusses and shipped them by rail to Waterville about two miles from the bridge site. The job of hauling these sections to place from the railroad was sublet.



BRIDGE TRUSS 90 FT. LONG BEING HAULED TO SITE BY TRACTOR

Each section weighed eighteen tons and was 90 ft. long and 14 ft. deep. They were hauled flat, as shown by the photograph, to the site, most of the two miles being through city streets. The work was complicated by the fact that the trusses had to be backed down 150 ft. between two buildings with a horizontal clearance of 40 ft.

The lowest bid received beside that of the Lombard Tractor Truck Corporation, who did the hauling, was $253. The Lombard company reports a cost of $30.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Short Courses for Plumbers

Sir—Your editorial comment of Feb. 10, 1927, entitled "Plumbers Next" with reference to the Plumbers Conference, held here at the Institute on Feb. 16-17, has been called to my attention, together with the letter from Prof. H. E. Babbitt, University of Illinois, and of R. S. Clark, Carnegie Institute of Technology, published in your issue of March 10. I would like to state that in planning the conference here I was familiar with the work done at both the institutions named; in fact, I wrote to Professor Babbitt and Professor Dibble of these institutions for suggestions in planning our conference and received much helpful advice from both. I wish to give them credit for assisting in this way in the planning of our conference, which was even more successful than we had anticipated, having a total registration of 477. R. G. TYLER,

Professor of Sanitary Engineering,
Massachusetts Institute of Technology.

Cambridge, Mass.,
March 21, 1927.

Proportioning Pit-Run Aggregate

Sir—The article "Proportioning Pit-Run Aggregate in Concrete" by Prof. J. H. Griffith, in *Engineering News-Record*, March 10, 1927, p. 399, shows how slowly a fundamental physico-mathematics of concrete materials and mixtures is being developed. As stated by Professor Griffith, the method of proportioning is based on the researches of Feret. Feret published his results in the "Annales des Ponts et Chaussées" (France) in 1892. Accordingly, the article does not recognize the principles established by more recent research, as will be discussed.

The formula of proportioning proposed by Professor Griffith is "Required mix of volume of aggregate (pit-run) to unit volume of cement, both measured by loose volume $= p - 3\frac{1}{2}$ (per cent sand in agg. + wt. of agg. per cu.ft.)," in which p varies from 10 to $12\frac{1}{2}$ for compressive strengths 2,400-3,000 to 1,200-1,800 lb. per sq.in. respectively. The percentage of sand is by weight passing a ¼-in. sieve and the weight of aggregate per cubic foot is understood to be for loose measured volume.

The use of pit-run aggregate is often a practical procedure in the production of economical concrete of the required quality and, for minor purpose structures of small volume, the use of the proposed method of testing and empirical formula of proportioning would be convenient as also for a quick approximation of the mix required by the run of the pit. It cannot, however, be expected to produce nearer than one cubic foot of cement to the most economical cement content for the concrete of required quality possible from the pit-run, and, for projects of 1,000 cu.yd., and more, daily technical control, employing more advanced methods of testing and of determination of proportions, would be more economical.

The stated theory of the proposed method of proportioning is that "the strengths of mortars and concretes are directly proportional to the cement contents and inversely proportional to the amount of voids (in the concrete) regardless of the nature and size of the sand, the proportions of the elements—sand, cement and water—of which each is composed." This disputes the water-cement ratio principle advocated by D. A. Abrams since 1918.

One does not need to be so wholly hypnotized by the water-cement ratio theory as to believe that it alone controls the strength, in order to appreciate the ample research data of Mr. Abrams which show that strength and density of concrete are very largely dependent upon this ratio. One of the bases of the theory advocated by Professor Griffith is that the strength is "inversely proportional to the amount of voids" in the mortar or concrete "regardless of . . . the proportions of . . . cement and water." It does not require any test data to observe that the voids in mortars or concretes are increased by increase of the water-cement ratio.

In so far as Professor Griffith's formula is true, it is largely dependent upon the water-cement ratio as: Strength is increased by increase of cement (as provided for by the formula) which allows the use of a lower water-cement ratio for the same consistency; and, strength is increased by increase of coarseness of the aggregate (decrease of sand content) which increase of coarseness decreases the water-cement ratio required for the same consistency.

The intricacies of the manufacture of economical and uniform concrete of quality are as complex as those of the manufacture of cement, steel and other products. This empirical formula of proportioning will produce neither uniform concrete nor the most economical concrete of the required quality. The use of any empirical formula of proportioning on concrete work of importance is not only costly but retards progress in the development of a fundamental physico-mathematics of concrete materials and mixtures—a development essential to economy and to an intelligent control of concrete production—and it contributes nothing to research in concrete.

We have maintained research laboratories and rigid daily control of aggregate and concrete production on projects of 3,000 to 450,000 cu.yd. with results in quality and economy paying the cost of testing and inspection on the small, and many times over on the large projects. The control procedure has consisted of preliminary tests of cements and aggregates; research of concrete mixtures, varying the grading and cement content for each grading and working consistency; daily testing of aggregates as received; adjustment of proportions as required; field testing and inspection; and making of daily compression and other tests of the concrete. Aggregates are tested for density, specific gravity, grading, fineness modulus, moisture, silt, organic matter, absorption, and bulking by loose measure and moisture. Concrete has been tested for density, weight per cubic foot, water-cement ratio, shrinkage in setting, cement per cubic yard, and other characteristics in addition to strength. These properties are determined before the concrete is used. Proportions are determined by weight, actual, dry-rodded, loose measured and inundated volume. Concrete research is made a regular operation of the construction and, as stated, this thorough control pays for itself in economy as compared with empirical control. Research data of great value have been developed, and we not only know the strength, or density, or weight of the concrete, but its exact structure in cement and aggregate particles.

In conclusion we ask, why devote so much work to the development of empirical equations when we have so much to learn about the exact and individual effects of quality of materials, coarseness of grading, uniformity of grading, cement content, cement-voids, sand-voids in rock, water-cement ratios, etc., upon the flexual, tensile and comparative strengths and upon the economy, density, weight, impermeability, ice, wear and chemical resistance of concrete, and when so little has been developed in the procedure and physics of concrete research itself? JOSEPH A. KITTS,

San Francisco, Calif., Kitts & Tuthill, Concrete
March 25, 1927 Technologists.

Tall Buildings Should Be Cylindrical

Sir—The recently proposed Larkin Tower in New York with an unprecedented height of 1,208 ft. is to be of square sectional design. For a building of such magnitude this choice of shape shows an apparent lack of engineering thought and esthetic sense as well.

In the construction of high buildings, the question of wind resistance is one of paramount importance. While it is of course possible to design a building of any given shape for rigidity under lateral loads, the use of circular outline reduces the effective wind pressure to 65 per cent. This value must be regarded as conservative, if the elimination of sucking effect due to more stream line flow of air around a curved surface is considered. The higher and more slender the structure, the greater is the effect of wind. A reduction of one-third or more in one of the predominating forces that the structure is supposed to resist results unquestionably in either economy of material or increased lateral stability of the structure as a whole.

The writer is aware that a cylindrical tower does involve more complicated construction, but not to such an extent as might appear at first thought. The steel skeleton frame does not necessarily have to be circular in outline. A polygonal figure could be used with the usual rectangle framing for the interior. With that arrangement only the outside line of spandrel beams is affected. It is true that an inscribed circle is smaller in area than the square and therefore yields less rental space. Yet it does not require very much encroachment outside the building line to make the circular area equal to that of the building lot and this extension is only over a small portion at the middle of each side.

Regarding the esthetic aspect of the subject, one does not have to be a trained architect to visualize that a cylindrical tower is infinitely more beautiful than an angular block. When coming generations come to appraise us by the multitude of standardized and ugly structures we leave behind, among which the Larkin Tower as proposed is a typical example in spite of its unusual height, we will be judged as a people of very commercial nature indeed and that only.

T. Kuo,
With American Bridge Co.

Trenton, N. J.,
March 23, 1927.

Iron as a Carrier of Oxygen—Submerged Contact Aerators

Sir—Recent articles and letters in your columns have seemed to me worth commenting upon from the Lawrence Experiment Station point of view. In *Engineering News-Record*, Feb. 3, 1927, p. 202, is an article by Abel Wolman concerning "The Rôle of Iron in the Activated-Sludge Process" which is of great interest. Experiments such as Mr. Wolman has carried on and suggests may lead up to a further development of that process. Thirteen years ago we tried at Lawrence the use of ferric chloride in an activated-sludge tank. Only small amounts were used and the results did not encourage further work along that line at that time. The fault may have been ours. In regard to iron as a carrier of oxygen, however, I should like to call attention to some work carried on by us nearly thirty years ago and in part summarized by me in the report of the Massachusetts State Board of Health for 1899. In this work intermittent filters constructed of mixtures of sand and iron filings, cinders and iron filings, and one filter constructed entirely of natural iron ore, namely, limonite or brown hematite—a hydrous sesqui-oxide of iron—were operated. The results in full of all this work are given in the reports of the Station but are too extended to present here. Quotations from this discussion are as follows, however. On p. 469 of that report is the statement:

"In the experiments which have been made at the Lawrence Experiment Station we have aimed to solve the question whether iron can be usefully employed as a carrier of oxygen and thereby assist the bacterial purification, or whether a chemical purification can be substituted to any extent for the action of micro-organisms."

Further discussion is given of this question on following pages of that report, and on p. 473 is the statement:

"But, as stated above, the general result of the operation of this tank (filter) was, up to the time when the dose was raised from 115,000 to 200,000 gal. per acre daily, more uniformly satisfactory than any intermittent filter which has ever been installed at the station. We were driven, therefore, to the conclusion that this admixture with the sand of fragments of metallic iron does have a favorable effect on the oxidation of organic matter of the sewage and also in the reduction of the number of bacteria; and it is highly probable that the active agent in promoting the purification of the sewage is the hydrated oxide of iron which forms on the surface of the iron fragments, and that iron does under these conditions act on sewage as it is known to act in many cases where it is in contact with organic matter exposed to the air, namely, as a carrier of oxygen to hasten decay."

At that time and after further experiments it seemed to us that in intermittent filtration, at least, the role of iron as an oxygen carrier was only of interest from a scientific point of view and could hardly be made use of in actual practice.

An article by Dr. Imhoff on "Submerged Contact Aerators" and letters from Langdon Pearse, and Dr. A. M. Buswell, appearing in *Engineering News-Record*, Dec. 30, 1926, p. 1087, and March 10, 1927, p. 420, impel me to say that the submerged aerator device was pretty thoroughly tried out by us at Lawrence, beginning in 1913; that as these aerators were first arranged accumulation of organic matter occurred to such an extent that it did become septic, as noted in Dr. Buswell's letter, this owing to the fact that these aerators were at first in a horizontal position in the aerated tanks. When changed to a perpendicular position, however, they did not become excessively coated, did not accumulate organic matter to such an extent that it became septic and were quite successful. Notes in regard to all this work are given in the reports of the Lawrence Experiment Station for 1912, 1913, 1914 *et seq.*

H. W. Clark,
Chief Chemist, Massachusetts Department of Public Health.

Boston, Mass.,
March 25, 1927.

Two Fire-Prevention Weeks Wanted

Sir—An article published in a recent issue of your paper, decrying the fire-prevention week of May next as being unnecessary because of the established fire-prevention week of October has been brought to the attention of the California State Association of Fire Chiefs, at a convention held in Sacramento on Feb. 28. I have been instructed to ask you to withdraw your opposition to the May week and to add your efforts to those of our association, the International Fire Association and other fire associations, who are carrying on a nation-wide campaign to endeavor to reduce the great loss of lives as well as the enormous financial losses by fire in this country.

Frank C. Stover,
Secretary, California State Association of Fire Chiefs.

San Francisco, Calif.
March 7, 1927.

Light Railways for Construction Job Haulage

Sir—It has always seemed to me that the light railway as developed and used on the western front during the war is quite generally overlooked as an ideal means of transportation on construction jobs. A recent article in your paper concerning the organization of the transportation system for the power development project on the Gatineau River in Quebec is a case in point.

On the job mentioned, a road was constructed for tractors and trailers; in the winter it worked very nicely and enormous loads could be hauled just as has been the practice for years in lumbering operations. Hauling in Canada in the winter is simple. However, in summer the tractors could haul but a small load as compared with the power used in hauling. The roads were rough and caused great wear and the dust increased the wear still further. It would seem that the load to be carried on the body of such a tractor is rapidly approaching the "vanishing point" as compared with what the same power can haul on a track or a smooth road.

The writer believes that to lay light railway through such a country after the manner used so extensively in France should compare favorably with the cost of preparing such a road as was prepared for the tractors. The supporting of such a track in bad ground is not as difficult, it would seem, as to corduroy for the tractors. The right-of-way could be considerably narrower as well. When the small locomotives used for light railway hauling leave the track they should be no more difficult to get back on the rails than the corresponding problem with the tractors; that is, getting them out of mud holes. Finally when you consider the hauling capacity of the light railway per unit of motive power the argument becomes interesting. It should be noted, in conclusion, that during the spring "break up" the road and tractors could not be used at all; it is believed that the light railway would not have been affected to such an extent.

Walter C. Carey,
Assistant Engineer, U. S. Engineer Dept.

New Orleans, La.,
Feb. 18, 1927.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Recommend New Wisconsin Highway Organization

Legislative Committee Reports on Recent Shakeup—Donaghey's Removal Criticized

After lengthy investigation of the recent shakeup of the Wisconsin Highway Department initiated by the state highway commission's abrupt dismissal of John T. Donaghey, chief engineer, on Jan. 25, a committee of the state legislature has rendered a report criticising the commission's action and recommending a new form of organization for the department. In place of the present commission of five, composed of three appointive and two ex-officio members (the state geologist and the dean of the college of engineering of the state university), the commission recommends "a full-time, well-paid commission of three members who will actively conduct the highway department."

REPORT ON DONAGHEY DISMISSAL

Discussing the dismissal of Donaghey without a hearing the report says:

"We deplore the apparent lack of courtesy and consideration and undue haste in the discharge of John T. Donaghey as highway engineer, without proper consideration and without giving him an opportunity to defend himself. The reasons given in the testimony for the removal of Mr. Donaghey seem frivolous and insufficient, and our judgment is that there is no evidence of incompetency or dereliction of duty on the part of Mr. Donaghey as chief engineer of the highway department. We find, however, that his successor, Mr. Kuelling, was not appointed through any improper or illegal motives, and that the charge that there were efforts made to control the highway commission or the operations of the department in the interest of any company or companies dealing in highway material or processes is not well founded."

Commenting on the appointment of a culvert salesman as member of the highway commission, the committee questions "the wisdom and propriety of appointing any person a member of the highway commission or to a position having control or supervision of the purchase of materials or letting of contracts who had personally been engaged in the sale of said materials or interested in such contracts."

In the testimony the opinion was expressed that concrete pavement as laid today has a life of 20 years. Referring to this, the committee points out that much of the concrete pavement is paid for by 20-year bonds, and questions the economic soundness of this practice. It doubts whether extensive laying of concrete pavement is warranted "until it is determined by usage and experiment what type of such pavement can be depended upon to give the most lasting service."

Under present conditions the Wisconsin Highway Department is spending about $15,000,000 annually in highway construction and supervising the expenditure of about $5,000,000 additional by counties.

New Jersey Legislature Modifies Control Over Port Authorities

The New Jersey legislature, on April 1, repealed the law passed a few days previously and noted in our issue of March 31, page 541, which gave the State House Commission veto power over all contracts of the Board of New York Authorities, including those for the Hudson River Bridge at New York. Before repealing the measure, however, it passed another bill giving the Governor veto power over the acts of any one of the New Jersey commissioners. Provision for such an act was made in the treaty between the two states, and a corresponding bill was passed by the New York State legislature when the New Jersey legislature took action on its original bill to place veto power in the hands of the State House Commission.

Engineering Fifty Years Ago

From *Engineering News*, April 7, 1877

THE engineers appointed by the Niagara Suspension Bridge Co. to examine and report upon the state and stability of the bridge have completed their duty, and reported to the effect that the bridge is entirely safe for the transit of regular trains such as have hithertofore used it. The commission consists of W. Milnor Roberts, chief engineer of the Northern Pacific R.R. and W. H. Payne, assistant engineer of the New York and Brooklyn Bridge. It is understood that a further report from these gentlemen is promised in a few days, giving tests, with drawings, and the reason in detail for the opinion expressed.

Governor Smith of New York has signed the bill appropriating $1,000,000 as and for the first annual installment which the state has heretofore undertaken to make available in aid of the construction by the Port of New York Authority of a bridge across the Hudson River at New York City, from Fort Lee to Fort Washington.

Mississippi Reaches 52.8 Ft. Gage at Cairo

Flood Stage Is Only 0.8 Ft. Below 1922 Though No High-Water Fight Is Anticipated

A moderate flood in the Ohio and a normal stage in the upper Mississippi Valley produced a crest of 52.8 ft. at Cairo, Ill., on March 25, but the river had fallen to 49.2 on March 31, reports Col. Charles L. Potter, chairman of the Mississippi River Commission. This crest was about 2 ft. below the record of 1913; 0.8 below the crest of 1922 and about 8 ft. above flood stage. On April 4 indications were that the crest would go down the valley at about these corresponding stages except that the grade would be considerably less relative to 1922 below White River due to the fact that the White and Arkansas rivers were in flood in 1922 and are at only moderate stages this year.

Heavy rains in the Lower Missouri, Middle Mississippi and Ohio valleys on the night of March 31 are sending another wave behind that already passed. Predictions are now that Cairo will reach about the same stage as the earlier crest. The two crests will tend to merge, producing slightly increased stages below Memphis but not material unless the White and Arkansas Valleys should get heavy rains.

"In general," wires Colonel Potter, "we have a good big flood stage from Cairo south but nothing to cause great worry. The only damage so far reported is the loss of a small levee section just north of the mouth of White River, due to excessive bank caving at a point which was considered safe for a year or two. In the absence of further rains, and there is nothing to indicate them, we do not expect a serious high-water fight."

N. Y. Grade Crossing Elimination Program Modified

Five bills embodying changes in the $300,000,000 grade crossing elimination plans of New York State have been approved by the governor. They were passed to simplify procedure looking toward elimination and to provide for a definite plan of operation. They also set up a system of budgetary control which was lacking heretofore.

Under the new arrangement the Department of Public Works will originate a grade crossing elimination program outside of the cities of New York, Buffalo, and Syracuse, which will be presented to the Public Service Commission. Similar programs will be prepared by the local grade crossing commissions at Buffalo and Syracuse and by the Board of Estimate at New York, the latter to submit its program to the Transit Commission.

Smith Opposes Toll Bridges in Veto Message

N. Y. Governor Thinks Time Past When State Should Incorporate Such Companies

On April 1 Gov. Smith of New York vetoed the legislative act authorizing the Thousand Island International Bridge Corporation to build a bridge across the St. Lawrence River near Collins Island, Jefferson County, over Wellesley Island to Ontario, Can. In his veto message the governor pronounced himself against further private toll bridge authorizations, and expressed the belief that when toll bridges are desirable or necessary they should be built by public funds. He said in his message:

GOVERNOR SMITH'S OBJECTIONS

"I think the time is past when the state should incorporate companies of this kind. Such bridges should be built either from public funds or through an agency such as the Port Authority of New York, authorized to issue bonds at a low rate of interest and limited in tolls to the amount necessary to retire and pay interest on the bonds. Experience with private bridges is that they result in large profits to stockholders and other private parties and the maintenance of high tolls. Bear Mountain bridge at Peekskill is a good example. This bridge was incorporated by private individuals who were genuinely interested in affording a new means of access to the Bear Mountain section of the Palisades State Park and the surrounding territory. The maximum tolls were fixed in the act. Interest on preferred stock was limited to 8 per cent but the company was permitted to issue share for share of common stock. The bridge was to revert at the end of thirty years to the state and there were provisions for recapture at a greatly lowered price in the course of the thirty years. It is already apparent that the bridge will not only pay the 8 per cent on the basis of tolls less than the maximum permitted to be charged, but will pay a large return on the stock, and that it would be a good business proposition, if the state had the money to take advantage of the recapture clause. The fact is that the state does not have the money available because of demands for other public improvements, and as a result a profit which ought to go to the public either in the form of reduced rates or in the form of returns which could be used for other improvements now goes into the pockets of private owners.

"Private bridges of this kind bring with them approach and traffic problems which in the end fall on the state and the municipalities and what looks at first like a purely private business proposition becomes a public problem of traffic and planning affecting all the surrounding territory. Obviously, these related problems which go with such a structure can only be properly solved by a public authority.

"I have just signed a measure setting up a public non-profit-making bistate authority similar to the port authorities of New York and Albany, to build the Champlain bridge, and also a measure providing for a study of a Niagara Port and Frontier Authority, which, if it is established, will have the power to plan just such bridges as this without private profit and solely in the public interest. I think this project and similar bridges, such as the Grand Island bridges, can wait until a public authority is established for the purpose. I see no more reason for a franchise to a private corporation to build a bridge over the St. Lawrence than I do for a franchise or license to a private corporation to develop the state's water power on that stream."

The Private Bills Committee of the Canadian Parliament, at a recent sitting refused to sanction the application of the promoters of the Thousand Island International Bridge Corp. to construct a bridge over the St. Lawrence River between Rockport, Ontario, and Collins Landing, New York. The application was strenuously opposed by Major Graham Bell, deputy minister of railways and canals, who pointed out that with the completion of the Welland Canal it would be necessary to have a bridge across the St. Lawrence at Prescott or Brockville, so that in winter access could be had to both Canadian and American boats, otherwise the grain would go to Ogdensburg and build up an American port, and so an expenditure of $110,000,000 on the Welland Canal would be lost. Charles B. Hibbard, New York banker, and Dr. C. E. Steinman, engineer, were the chief spokesmen for the proposed project.

Paul Declines Appointment as Flood Control Consultant

Charles H. Paul, who was mentioned in these columns last week as having been named a member of the consulting board of the Los Angeles County Flood Control District, has declined to serve. Mr. Paul was a member of the board of engineers appointed by the supervisors to review the work of the commission under J. W. Reagan, chief engineer, who has resigned that post to become a one of three on the consulting board, membership on which Mr. Paul declines.

Eaton Long on Hydraulic Work

E. C. Eaton, who has been named chief engineer of the Los Angeles County Flood Control District to succeed J. W. Reagan, now a member of a three-man consulting board, has been with the commission but a short time, having been named Mr. Reagan's asssitant several months ago. Mr. Eaton went to Los Angeles from Sacramento, where he had been employed on similar work in the state engineering department. For five years he was with the state irrigation engineer charged with reporting on irrigation bond matters and was also in charge of construction of state or state-aid dams. In this latter work he became familiar with the work in the Los Angeles district. Mr. Eaton is a graduate of McGill University and a native of Rhode Island.

Important Ruling Made on Railway Valuation

Commerce Commission Expresses Its Views in Order Having Wide Effect if Sustained

A complete discussion of the views of the majority of the Interstate Commerce Commission on proper methods of determining the value of railroad property used in the transportation service of the country is given in its decision of the matter of the recapture of excess earnings of two small railroad companies. The importance of this decision lies in the fact, as stated by the commission, that "what we do in this case we must, in principle, do for all the railroads of the United States. Whatever our decision, its effect in dollars and cents is relatively unimportant in this particular case. But, having in mind, as we must, the railroad situation, the decision is of the greatest consequence from both private and public viewpoint." The views of the majority are briefly stated in the following paragraph:

"Value rests upon a number of elements. The value of the property of railroads for rate-making purposes, which is construed to be the value of property devoted to common-carrier purposes upon which common carriers are entitled under law to earn a fair return, approaches more nearly the reasonable and necessary investment in the property than the cost of reproducing it at a particular time."

CASE AT ISSUE

The case before the commission was that of two small railroads, the St. Louis & O'Fallon Ry. Co., and the Manufacturers Ry. Co., both owned by the Adolphus Busch estate. The question at issue was the recapture of excess earnings under sections of the Interstate Commerce Act which provide that all railroads shall pay over to the Interstate Commerce Commission, for the purpose of forming a railroad contingent fund, one-half of all net income in excess of 6 per cent of the value of their property devoted to railroad service. In order to determine what, if any, excess there was, it was necessary for the commission to first determine what was the value of the property of the two railroad companies devoted to the transportation service of the country. By a six to four decision it arrived at such a value, and as its methods are, as stated above, to be used in valuing the properties of all the other railroads, the majority stated its views at great length, the minority adding its dissenting views. Those views are too long to be given here. They will be abstracted at considerable length in next week's issue.

In addition to the expression of opinion on the subject of values, the decision of the commission in this case has another interesting feature. The two railroad companies have no physical connection, except over the lines of another railway, but are owned by the same company. The Manufacturers Ry. is simply a switching railway with only a small net income, while the O'Fallon Ry. originates considerable freight and

has a large net income, part of which, according to the commission's method of valuing its property, is recapturable. However, if the two railroads, as claimed by the owners, are considered as one system, the low earnings of one offset the excess earnings of the other, and there is no surplus for recapture. As all the officers are the same, and the same general officers and shops serve both roads, the owners claim that they constituted a railroad system. The majority of the commission did not approve of this interpretation of the Transportation Act, on the ground that common ownership and operation does not, of necessity, create a railroad system. Commissioner Taylor dissented from this view, stating that his idea of the consolidation provisions of the Transportation Act was that they were put in for just such a purpose, namely, for the strong roads to carry the weaker roads, and so give the country a better transportation system.

Tacna-Arica Boundary Board Re-assembles in New York

The Special Commission on Boundaries, Tacna-Arica Arbitration, has reassembled in New York after a recess entered into at Tacna, Chile, last August, when all field work had been completed on the northern boundary of the disputed provinces. The commission was appointed by President Coolidge under the arbitration pact between Chile and Peru, and should not be confused with the Plebiscitary Commission which was dissolved last summer due to the failure of the plebiscite.

The boundary commission consists of Brigadier-General Jay J. Morrow, chairman, Senor Luis Riso Pation (a distinguished topographical engineer and geographer), delegate from Chile, and Col. Oscar H. Ordonez, (distinguished engineer officer of the Peruvian Army) delegate from Peru. The commission will shortly proceed to Washington, and after study of the cases and counter-cases of the respective parties (Chile and Peru) will submit its findings on the northern boundary to the arbitrator, President Coolidge.

Courts to Enforce Protection of N. Y. Water Supplies

An act authorizing any court of competent jurisdiction to "enforce prompt compliance" with emergency orders of the New York State Commissioner of Health to remedy public water-supply conditions that menace the public health has been signed by the governor as Chap. 254 of the Laws of 1927. The act applies to any public water supply regardless of ownership. Before a court order can be obtained the commissioner of public health must investigate the water supply and certify to the responsible water authority that, "in his opinion," it "is so polluted or subject to dangerous pollution as to constitute a menace to the public health and shall order reasonable emergency measures to be applied." If the order is not carried out "forthwith," court application may be made as already stated.

Chicago Voters Authorize $21,000,000 in Bonds

Bond issues totaling $21,000,000 were approved by the voters of Chicago in the municipal election of April 5. River straightening and bridge construction, street widening, lighting and traffic-control signal extension are among the important items of work to be carried out with these bonds. Several of these items were opposed by commercial and civic organizations, among them the Wabash St. bridge (held to be premature) and street lighting and signaling (considered to be chargeable to current expenditures rather than bond issues). The whole list of issues was approved in the election, however.

Edward J. Mehren to Report Geneva Economic Conference

Edward J. Mehren, vice-president of the McGraw-Hill Publishing Co., will sail April 20 to report for the various McGraw-Hill publications the sessions of the International Economic Conference to be held in Geneva, Switzerland, May 4. Mr. Mehren will sail on the same boat with the American delegates to the conference, appointed by President Coolidge, who are: Henry M. Robinson, of Los Angeles, who served on the Dawes Commission; Norman H. Davis, of New York, Assistant Secretary of the Treasury and Assistant Secretary of State in the Wilson Administration; John W. O'Leary, of Chicago, president of the Chamber of Commerce of the United States; Alonzo E. Taylor, of Stanford University, who was associated with Herbert Hoover during the war; and Dr. Julius Klein, director of the Bureau of Foreign and Domestic Commerce.

Delaware River Compact Left in Abeyance

No action on the second attempt at a Tri-State Delaware River Compact for the allocation of the waters of the Delaware River was taken by the New Jersey Legislature before adjournment on March 30. A similar fate is expected in Pennsylvania, which will leave the compact in abeyance until 1929, owing to biennial sessions in that state. The New York Legislature approved the later attempt at a compact, as it also did the first attempt.

Col. Ladue Succeeds Bell as District Commissioner

Col. William B. Ladue, now on duty as engineer officer on the staff of the commanding officer of the Second Corps Area, Governors Island, N. Y., has been detailed to the post of engineer-commissioner of the District of Columbia. Colonel Ladue succeeds Lieut. Col. J. Franklin Bell, whose duty expires in June. Colonel Bell is in Panama, where he plans to make a study of the various problems in connection with the maintenance of the canal locks. He will probably return to Washington about May 1.

Colonel Ladue is fifth on the list of colonels in the Corps. He was born at Adrian, Mich., in 1868 and attended the University of Minnesota, from which he was graduated in 1889 with the degree of bachelor of arts. A year later he was appointed to the United States Military Academy from Oregon, and graduated No. 1 in his class on June 12, 1894. He served for a considerable time after the Spanish War in the Philippines and during the World War organized and commanded various engineer regiments at Camp Funston, Fort Benjamin Harrison, Camp Forrest and Camp Meade. Since the World War Colonel Ladue has served in Panama as post commander, regiment commander and department engineer, relinquishing the latter post in 1924 to assume the one which he now holds.

Negotiations for St. Lawrence Canal to Start Soon

The State Department has notified the Great Lakes Tidewater Association that it will begin negotiations in the near future looking toward the treaty under which the construction of the enlarged waterway down the St. Lawrence River from the Great Lakes can be undertaken jointly by the two countries. It is the hope of the association that such a treaty may be prepared in time for presentation to Congress in December.

Arlington County, Va., Granted Zoning Powers

Zoning powers are granted to the board of supervisors of Arlington County, Va., adjoining the District of Columbia, by a legislative bill signed by the governor on March 30. The bill authorizes the supervisors "to regulate the use of land and of buildings or other structures and the height thereof and also to establish building lines and to regulate and restrict the construction and location of buildings and other structures." The supervisors will appoint a zoning commission of five members to frame zoning regulations for enactment by the supervisors and the Circuit Court of Arlington County will appoint a board of zoning appeals, from which cases may be carried to the court.

Johns Hopkins Education Plan

Dr. Frank J. Goodnow, President of The Johns Hopkins University, has authorized the following statement in reference to the future of the School of Engineering:

"Much interest has been displayed in the new plan for university work at The Johns Hopkins University. This plan applies particularly to the philosophical faculty. For the present, the school of engineering will continue as formerly to offer its regular four-year undergraduate courses and graduate instruction. Only such changes in curricula will be made as are necessary to conform with the modified courses in the College of Arts and Science."

Washington Notes

BEFORE sailing for Honolulu from San Francisco on March 30, Secretary of the Interior Work named the members of a commission to make a survey of the Boulder Dam project. These appointees are United States Senator Charles W. Waterman of Colorado; Governor Frank C. Emerson, Wyoming; William F. Durand, professor emeritus of Stanford University; James R. Garfield, former Secretary of the Interior and James G. Scrugham, former Governor of Nevada. Secretary Work has asked the committee to meet him at Yuma, Ariz., April 29, where the first meeting will be held. The committee will make a survey of the lower Colorado River, inspect Boulder Canyon and other dam sites and report its findings after investigation of the Colorado River situation to the next Congress in December.

A CAMPAIGN of education in support of the Campbell bill to restrict Federal agencies in performing construction work with their own forces will be carried on during the summer and fall by the Associated General Contractors, which organization is sponsoring the measure.

The contractors are not at all disheartened because Congress failed to come to a vote on the bill at its last session, according to Gen. R. C. Marshall, Jr., general manager of the A. G. C. As a matter of fact, in view of the conditions confronting this measure, the officers of the A. G. C. appear well satisfied with the progress made in the 69th Congress. A favorable report on the bill by the House judiciary committee, with only three members of that body signing the minority report in opposition, is considered an achievement.

While two apparent efforts were made to secure a special rule for the consideration of this bill in the House, these have been interpreted as strategic moves to develop the sources of opposition to the measure in Congress rather than a serious attempt to force a vote. Proponents of the bill now say that it was not a part of their plan to attempt to bring about a vote through a special rule as under that legislative procedure, it would have been necessary to have secured a two-thirds majority in favor of the measure. They do not claim to have had a two-thirds majority of the House in support of their bill at the last session but assert that sufficient ground was gained to encourage them to believe that a more serious effort towards passage will bear fruit in the next Congress.

RIVER and harbor improvements are proceeding at a rate far in advance of that ever attained heretofore. In recent years Congress has been more generous in voting funds for that purpose. The 1927 act carries $50,000,000, as did the act of 1926. In 1925 the funds made available aggregated $40,000,000. The 1924 act carried $37,250,000. Thus the availability of large sums for a period of consecutive years is being reflected in the volume of work in process and the number of projects being completed. This is in addition to $10,000,000 annually being expended on flood control, in compliance with the six-year authorization.

BECAUSE of the failure of the recent Congress to enact certain legislation, Controller General McCarl has advised the Secretary of State that the work of the Commission on Equitable Use of the Waters of the Rio Grande will cease at the close of the present fiscal year, June 30, 1927. This commission has been working with a similar commission of Mexico.

A.G.C. Boards to Meet May 2-5

Announcement has been made that the regular spring meeting of the Executive Board, Advisory Board, President's Council, and Secretary's Council of the Associated General Contractors will be held at Washington, D. C., May 2-5, the final day being devoted to sessions of the Secretary's Council. The headquarters of the meeting are to be at the Hotel Washington and all sessions will be held there.

Changes in Erie R.R. Engineers

In the engineering organization of the Erie R.R., changes have been made by which R. C. Falconer, formerly chief engineer and assistant to the president, becomes engineering assistant-vice-president; R. S. Parsons, vice-president in charge of operation, becomes chief engineer; while G. S. Fanning, principal assistant engineer, is made assistant chief engineer, and J. C. Patterson, regional engineer of the New York region, is now superintendent of maintenance. All of these officers are located at New York. In addition, I. H. Schram, regional engineer of the Chicago region, is made engineer of maintenance-of-way, with headquarters at Hornell, N. Y., while H. Knight, regional engineer of the Ohio region, has his jurisdiction extended over the Chicago region, his headquarters remaining at Youngstown, Ohio.

Canadian Railway to be Extended

It has been announced officially that the Ontario Government will extend the Temiskaming and Northern Ontario Ry. into the Rouyn mining district of Northwestern Quebec. Construction work will commence in the very near future. Premier Ferguson also has announced that the extension of the railway northward from the present end-of-steel will also be under way this year, and that it is hoped to make considerable headway towards James Bay.

Power Survey Bill Vetoed

The bill to create a temporary commission to study and investigate the water-power situation in the State of New York has been vetoed by Governor Smith "for reasons repeatedly stated, as it would waste the public funds and accomplish no useful purpose."

Personal Notes

RICHARD W. JOHNSON has been appointed engineer for the Concrete Reinforcing Steel Institute. He was formerly with the Portland Cement Association and at one time assistant city engineer of Indianapolis. He is a graduate of the United States Military Academy.

BRIG.-GEN. THOMAS Q. ASHBURN, chairman of the advisory board of the Inland Waterways Corporation, has been promoted to the rank of major general.

FRED E. BECK, for several years chief engineer of the Consolidated Water Co., Utica, N. Y., has been made vice-president of the Rochester & Lake Ontario Water Co., Rochester, N. Y.

ALBERT E. BERRY has received the appointment of provincial sanitary engineer in the Ontario Department of Health, succeeding F. A. Dallyn. Dr. Berry has been with the department for a number of years. The work of this division includes the supervision of the water-works and sewerage systems in the province and general sanitation in the various municipalities, together with the operation of an experimental station.

G. H. FERGUSON, as chief sanitary engineer of the federal department of health of Canada, will carry on engineering work in Canada on lines very similar to those of the engineering branch of the U. S. Public Health Service, and will also co-operate with that organization in matters that concern United States and Canada. Mr. Ferguson has been engaged in public service in Canada for about twenty years in which period he has been employed at various times by the Department of Interior; Hydro-Electric Power Commission of Ontario; Canadian Commission of Conservation; Grand Trunk Ry. Arbitration Board; Toronto Transportation Commission; Federal Department of Health, Canada; in addition to serving overseas in France and Belgium as an officer of the Canadian Engineers.

DR. ALFRED EISENSTEIN of Vienna, Austria, and H. B. Jespersen of Copenhagen, Denmark, are spending a few weeks with Arthur D. Little, Inc., of Cambridge, Mass., with whom they are associated as European correspondents and consultants.

H. B. ALBERTS, Green Bay, Wis., was elected city engineer for New London, Wis., to succeed Harlow Millerd, resigned.

HUGH W. CRAWFORD, of Kansas City, Mo., has been appointed city engineer of Ponca City, Okla., following the resignation of E. A. JONES, city engineer for the past four years, who will locate at Enid, Okla., as a consulting engineer. From 1920 to 1924 Mr. Crawford was city engineer of Independence, Kan., and since the latter date was in consulting practice in

Kansas City. For eight years prior to 1920 he was with the Engineer Corps of the United States Army.

THE DERBON CONSTRUCTION CO., INC., Seattle, Wash., announces the opening of an office in San Francisco, Calif., at 315 Montgomery St. ORO MCDERMITH is president and JOHN B. BONNY is vice-president of the company; its Seattle office is in the Colman Building.

IRA B. SAFFORD, of Auburn, Maine, has been appointed assistant manager of their Cuban highway project by the Warren Brothers Co., of Boston, Mass. This project is the 700-mile Central Highway described in this issue of *Engineering News-Record*, p. 558. Mr. Safford is a graduate of the University of Vermont, served in France and since the War has been a captain in the Engineers Reserve Corps of the Army, and for the past four years has been in Auburn, Maine, three years of which were spent as superintendent of streets.

S. L. RUGGLES, civil engineer, for the past two years associated with E. Worthington, consulting engineer, Dedham, Mass., has been selected as the first joint manager of the town of Rockingham and the village of Bellows Falls, Vt. Mr. Ruggles is a graduate of Dartmouth College and received his C. E. degree from the Thayer School of Civil Engineering. Before going to Dedham he was for five years city engineer and superintendent of the water department at Barre, Vt., following eleven years of engineering instruction.

HIRAM A. R. GRAY, at present an associate civil engineer in the coast guard division of the Treasury Department in Boston, has been appointed town manager of Rumford, Maine.

J. W. YOUNG, formerly assistant engineer with the Richmond Construction Co. at Galveston, Tex., has been made an assistant engineer on the Fort Worth & Denver City Ry.

WILLIAM K. REED, civil engineer, Sacramento, Calif., has been appointed city engineer of North Sacramento, Calif., succeeding JOHN N. BIDWELL, who has resigned to go into private engineering practice. Mr. Reed will have charge of street improvement work to be done at North Sacramento.

JOSHUA D'ESPOSITO, chief engineer and general manager of the Chicago Union Station Co., has resigned from active connection with the company, but will continue as its consulting engineer. Mr. D'Esposito was chief engineer during the several years of construction work on this extensive enterprise and was given the additional duties of general manager when the new station was placed in full operation in 1925.

H. W. TATE was recently appointed assistant general manager of the Toronto Transportation Commission. Mr. Tate was formerly engineer of way for the commission. He was born at Wimbledon, England, in 1884 and went to Canada in 1905. He graduated from the Faculty of Applied Science, University of Toronto, in 1910, with the B.Sc. degree. He was one of the first engineers appointed after the Toronto Transportation Commission was formed.

T. H. SANDERSON has been appointed assistant city engineer of Sault Ste. Marie, Ont. Mr. Sanderson was formerly observer for the Forestry Branch of the Ontario Air Service.

EDGAR B. KAY, chief of the Hydraulic and Sanitary Branch Office of the Quartermaster General, War Department, has resigned and has established offices in the Bond Building, Washington, D. C., as a consultant in hydraulic and sanitary engineering work. Mr. Kay was for a number of years before the World War dean of the College of Engineering, University of Alabama, and is the inventor of the government type incinerator, known as the U. S. Standard.

MAJOR E. E. TALMADGE, who has held the position of assistant superintendent of grounds and buildings, department of the General Electric Co. at Schenectady, N. Y., has been transferred to the West Philadelphia Works of the company as superintendent of a newly-organized grounds and buildings department at these works.

AUGUST ZIESING, president of the American Bridge Co. since 1905, has resigned from the presidency of the company. Mr. Ziesing, born in Illinois in 1858, has been in bridge work since 1878, the year of his graduation from the University of Illinois. For two years he was a draftsman with Mr. Lassig on bridge design and construction, and two years bridge engineer and assistant engineer with the Pennsylvania Co. at Pittsburgh, serving both on structural work and on railway relocation and construction on several lines in Ohio. In 1882 he became chief draftsman with the Lassig & Alden Bridge Co. in Chicago and remained with this company and its successor, the Lassig Bridge & Iron Works, for 15 years, becoming chief engineer and manager. In 1897 he resigned to enter private practice. Upon the formation of the American Bridge Co. in 1900 he became its western manager, and in 1905 its president. In the latter year he received the degree of civil engineer from the University of Illinois. As president of the American Bridge Co. Mr. Ziesing has been connected with many of the largest bridge projects in the country for more than twenty years.

JOSHUA A. HATFIELD, one of the vice-presidents of the American Bridge Co., has been elected president following the resignation of August Ziesing. Mr. Hatfield has been a director of the American Bridge Co. since its formation in 1900. Until 1914 he was president of the American Bridge Co. of New York, which was then consolidated with the American Bridge Co. (of New Jersey) to form the present company, at which time he became its vice-president. In his earlier career he served with the Pottstown Iron Co., Pottstown, Pa., rising to the position of general sales agent, and with the Pencoyd Iron Works, Philadelphia, as executive.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Spring Meeting, Asheville, N. C., April 20-22, 1927.

BUILDING OFFICIALS CONFERENCE, Portland, Ore.; Annual Meeting, Chicago, April 26-29.

AMERICAN WELDING SOCIETY, New York; Annual meeting, New York City, April 27-29.

NATIONAL CONFERENCE ON CITY PLANNING, New York City; Annual Meeting, Washington, D. C., May 9-11, 1927.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Chicago, Ill., May 9-12, 1927.

SOCIETY OF INDUSTRIAL ENGINEERS, Chicago, Ill.; Annual Meeting, Chicago, Ill., May 24-27, 1927.

CONFERENCE OF STATE SANITARY ENGINEERS, Washington, D. C.; Annual Meeting, Chicago, Ill., June 4-6, 1927.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Tulsa, Okla., June 6-8, 1927.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Chicago, Ill., June 6 to 11, 1927.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, French Lick, Ind., June 20-24, 1927.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, New York City; Annual Meeting, Orono, Maine, June 27-30, 1927.

The Florida Engineering Society held its eleventh annual meeting in Clermont, Florida March 21 and 22. Papers discussed "City Planning in Florida," by Charles W. Leavitt; "Engineering Consciousness," by H. D. Mendenhall; "Pressures Back of Seawalls," by C. H. Ruggles; and "The Control of the Kissimmee River," by C. C. Browne. The officers elected are: George W. Simons, Jr., Jacksonville, president; C. A. Brown of Orlando and J. E. Craig of Jacksonville, vice-presidents; J. R. Benton, Gainesville, secretary; G. A. Main, of Daytona Beach, treasurer.

Obituary

RALPH E. HAVENS, engineer in charge for the General Engineering & Management Corporation, New York City, at the power house and dam which this company is building near Tallahassee, Florida, died March 28.

RUDOLPH H. PEPPMULLER, for 21 years an assistant architect engaged in designing the stations of the rapid-transit subway system of New York City, died April 4 at his home in New York City, aged 53 years. In 1906 Mr. Peppmuller joined the staff of the Board of Rapid Transit Railroad Commissioners of New York City and since the creation of the new Board of Transportation had been on its staff specializing in design and specifications for subway stations.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer is Doing for the Engineer and Contractor

Add New Variety to Paving Brick Standards

Standing Committee Increases Number to Five with 2½x4x8½-in. Plain Wire-Cut Size

At its annual meeting in Washington March 31 the Standing Committee on Simplification of Varieties of Paving Brick added the 2½x4x8½-in. plain wire-cut brick to the "recognized" list, thus increasing the number to five. This is the first time that a variety has been added, previous action of the committee having always been the elimination of varieties or the approval of previous action.

The 2½x4x8½-in. plain wire-cut brick was one of the 55 varieties excluded from the recognized list at the first conference in 1921. Its shipments in the previous year had been only 2.3 per cent of the total. This percentage was maintained in 1921 and 1922. In 1923 its shipments rose to 2.7 per cent, in 1924 to 4.4, in 1925 to 8.9 and in 1926 to 14.1.

In a report from all producing companies submitted to the committee, and made at the request of the Department of Commerce, the total shipments in 1926 were shown to be 413 million brick, compared with 353 million in 1925. Of the total 65 per cent were in the four recognized varieties, as against 74.2 per cent in 1925. The decrease was due to the rapid increase in shipments of 2¼-in. brick. With the shipments of this brick, now a recognized variety, added to the four earlier recognized varieties, the shipments of the five in 1926 totaled 79.1 per cent. The details are as follows:

	Per Cent of Total	
	1925	1926
Plain wire cut		
2½x4x8½	8.9	14.1
3x4x8½	40.7	38.2
3½x4x8½	5.5	5.9
Repressed lug		
3½x4x8½	21.0	14.5
Wire-cut lug (Dunn)		
3½x4x8½	7.0	6.4

The Standing Committee and the organizations they represent are: Chairman, Edward J. Mehren, McGraw-Hill Publishing Co.; J. St. John Wilson, Bureau of Public Roads; P. H. Bates, Bureau of Standards; R. Keith Compton, American Society of Civil Engineers; George F. Fisk, American Society for Municipal Improvements; O. W. Renkert, American Ceramic Society; Edward E. Duff, Jr., National Paving Brick Manufacturers Association; T. R. Lawson, American Society for Testing Materials; E. W. McCullough, U. S. Chamber of Commerce; G. F. Schlesinger, American Association of State Highway Officials; R. M. Hudson, Department of Commerce. All the members of the committee were present except Mr. Fisk, who was represented by Colonel Compton.

Sixth Conference on Asphalt Paving Announced

The sixth annual asphalt paving conference will be held at the Atlanta-Biltmore Hotel, Atlanta, Georgia, during the week of Nov. 28, 1927. The conference is held under the auspices of The Asphalt Association, of which J. S. Helm of the Standard Oil Co. of New Jersey, New York City, is president.

The Association of Asphalt Paving Technologists, of which Hugh W. Skidmore of the Chicago Paving Laboratory is president, will co-operate with The Asphalt Association in the holding of a joint conference.

The fifth annual asphalt paving conference was held at Washington in November, 1926, and brought together more than six hundred state, county and city engineers, paving contractors, asphalt producers, consulting engineers and others identified with asphalt paving.

Drain Tile in Wisconsin and Iowa

An output of about 600 carloads of drain tile from Wisconsin factories during 1926 is noted in a report by E. R. Jones, state drainage engineer. About 400 carloads were of tile 8-in. or less in diameter, averaging nearly a mile to the car. From 1912 to 1915 there were about 1,200 carloads of tile annually laid in Wisconsin. The state of Iowa lays about 600 carloads of tile a year on its highways alone. In Wisconsin practically all of the tile laid is on farms, for agricultural drainage.

Business Notes

MOTOR TRUCK ASSOCIATION OF ILLINOIS is the new name for the Motor Truck Association of Chicago whose formation was announced in *Engineering News-Record*, March 24, p. 506.

POLDI STEEL CORP. OF AMERICA, 151 Bank St., New York, announces that it is now prepared to offer both a hollow and solid mining drill steel manufactured under a new process by the Poldi Steel Works of Czechoslovakia. These drill steels use high grade iron made from Styrian ores. The steel is electric furnace steel. All standard sizes and shapes will be supplied in various length bars, up to a maximum length of 30 ft.

BAILEY METER CO. is the name of the new company being formed to acquire the flow meter business of the General Electric Co. and the fluid meter and combustion control business of the present Bailey Meter Co. The principal holder of stock in the new company is the Babcock & Wilcox Co., New York. This company will have its factory and general offices in Cleveland, Ohio. E. G. Bailey is president; R. S. Coffin, vice-president of the present Bailey Meter Co., will be vice-president in charge of administration and finances, and R. E. Woolley, now with the General Electric Co., will be vice-president in charge of engineering and sales.

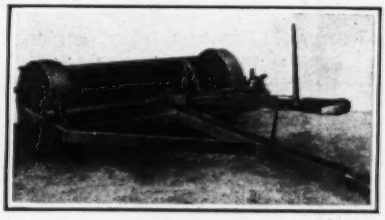
R. H. BEAUMONT CO., Philadelphia, announces it has taken over the business of the American Mfg. & Engineering Co., Kalamazoo, Mich. This company, among other things, manufactures the American slack line cableway excavator. S. O. Nafziger, president of the American Mfg. & Engineering Co., will be associated with the R. H. Beaumont Co.

SHEPARD ELECTRIC CRANE & HOIST CO., Montour Falls, N. Y., has taken over the entire Sprague portable hoist business of the General Electric Co. The Shepard company will continue the manufacture of the Sprague hoist and has established for this purpose a division of the company with offices at 30 Church St., New York City. N. A. Hall of the General Electric Co., will take charge of the new Shepard division, after 14 years of service with General Electric.

New Developments

Tractor-Operated Fresno Scraper

In the new rotary fresno scraper for earthwork excavation and grading, brought out by the Western Wheeled Scraper Co., Aurora, Ill., the pan turns entirely over when dumping and can be stopped and held in reversed position so as to spread and level the dumped material. This large scraper is intended specially for use with a tractor, and the pan can be dumped, righted and returned to loading position without stopping the tractor. For loading, the pawl in the segmental rack is released and the long upper arm is raised, allowing the pan to drop with its cutting edge on the ground. When the pan has been filled by its forward

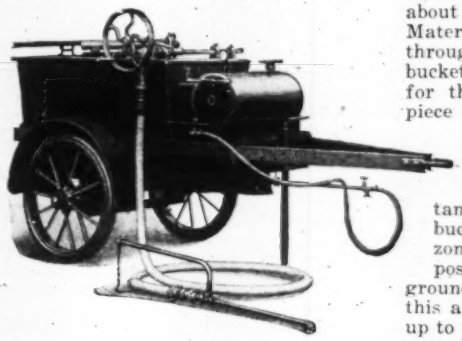


travel, the long arm is pushed down, raising the pan and locking it in position for transportation. To dump the contents, the upright lever at the end of the arm is pulled, the pan then rotating until lugs in its side strike the large ratchet or star wheels, which thus hold the pan in position for spreading the load. It can be held at different levels by shifting the positions of the lugs. If it is not desired to spread the

pile, the lever is held over until the lug passes the ratchet, so that the edge of the pan will rise high enough to be clear of the pile of dumped material. The pan will then be held by means of a second lug, until released to drop back to the loading portion.

Asphalt Melting Kettle Improved

The oil-burning tar and asphalt melting kettle, Model 84-W, of Littleford Bros., Cincinnati, Ohio, has recently been improved in several details. The compressor pump for the fuel tank is now submerged in the tank, thereby eliminating outside piping and the danger of leaky joints. Splash guards



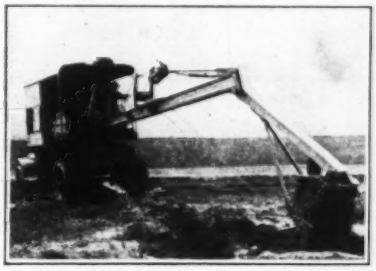
have been provided to reduce the chance of spilling, and a new type of burner is used which is claimed to be much more economical to operate than the old one. The asphalt tank is provided with a larger strainer which improves the flow of melted material. The cover is made in two sections as previously, but one section is bolted down and the other hinged to it. The kettle is made in three capacities 50, 75 and 110 gal.

Pull Shovel Attachment for Truck Crane

A new piece of equipment for attachment to the truck cranes manufactured by the Universal Crane Co., Cleveland, Ohio, consists of a ⅝ yd. pull shovel or trench hoe as illustrated.

Three major parts make up the attachment: a 19 ft. boom, a dipper arm and an auxiliary A-frame member which is designed to take the stresses and strains of trench hoe operation. The attachment is adaptable to use with any Universal with double drums separately driven. It is readily and quickly transferable with the standard crane boom for use with clamshell or dragline bucket, hook block, backfiller board, etc. The attachment has a maximum reach of 26 ft. and a digging depth of approximately 13 ft., mounted on a standard 5 ton motor truck. It is said that with the trench hoe working at the maximum radius the unit possesses the same stability as with the standard 24 ft. crane boom and ¾ yd. clamshell bucket.

An exclusive feature of this attachment is the automatic tilt bucket for dumping materials directly into trucks. The ⅝-yd. bucket is hinged at

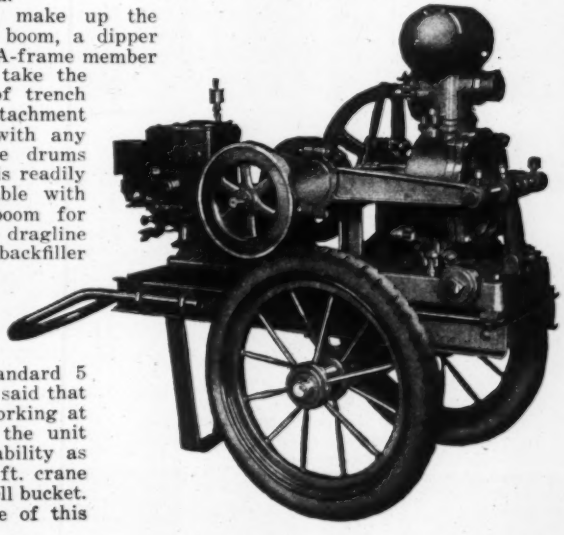


the front end and arranged to pivot about this point for spilling materials. Material is taken in and dropped through the front open end of the bucket. Several advantages are claimed for this design: the bucket is a one piece bucket with a maximum of strength not permitted in buckets with hinged bottom; with this style tilt bucket, there is no decrease in clearance distance between the ground and the bucket as it is tilted from a horizontal position to the tilt dumping position; 8½-ft. clearance from the ground to bucket is easily obtained with this arrangement and can be increased up to 12 ft.; the bucket can be operated very close over the truck, reducing the distance materials must fall and the resulting impact on the truck body.

The pull-in speed of this attachment is 65 F.P.M. The ⅝-yd. bucket is 32 in. wide which with side teeth will cut a 40-in. trench.

Diaphragm Pump Mounted on Trailer for Rapid Portability

The trailer mounting designed for its diaphragm pump by the Humphreys Mfg. Co., Mansfield, Ohio, uses rubber-tired wheels and is claimed to be evenly balanced and easily handled by one man. In connection specifically with the pump, accessibility is said to be one of the outstanding features. Without dismantling any part of the pump, a diaphragm can be replaced by removing five brass nuts. An air chamber in the discharge manifold is said to absorb a large portion of the strain. The pump is equipped with rotating rubber ball valves and although designed for force drainage work, it is also suitable for open spout operations.



Manufacturers and Trade Associations

Calendar

Annual Meetings

AMERICAN WELDING SOCIETY, New York; Annual meeting, New York, April 27-29.

NATIONAL LUMBER MFRS. ASSOCIATION, Washington, D. C.; Annual meeting, Chicago, April 28-29.

NATIONAL LIME MANUFACTURERS' ASSOCIATION, Chicago; Annual meeting Chicago, April 28-29.

WATERWORKS MANUFACTURERS ASSOCIATION, New York; Annual meeting, Chicago, June 6-10.

New Publications

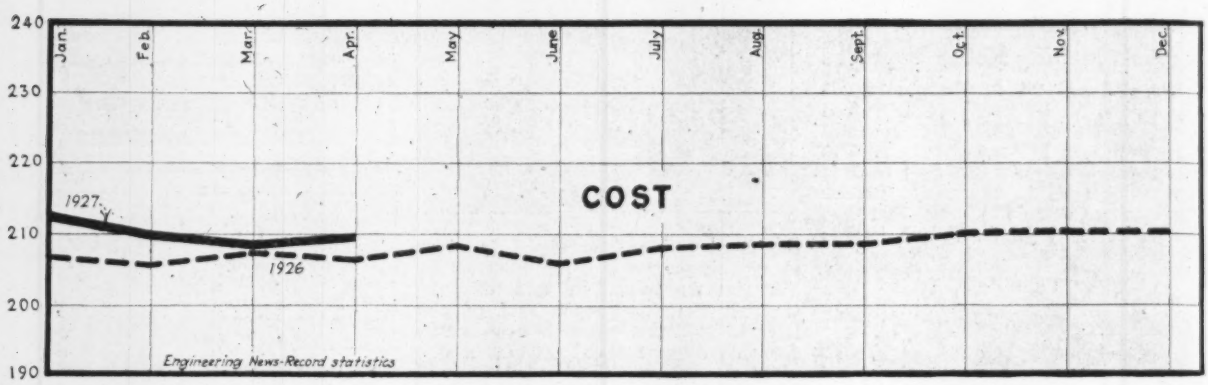
Road Building Equipment—AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C., has issued a 550-p. catalog-directory of road building equipment and materials. From 1 to 5 pp. are devoted to descriptions and illustrations of each manufacturer's products. As an aid to the user of the catalog, a classified index of products is given as well as an alphabetical index of firm names. Some 300 companies, past exhibitors at the Chicago Road Show, are represented in the catalog.

Track Shifting and Lifting Machine—THE NORDBERG MANUFACTURING COMPANY, Milwaukee, Wis., has issued an 8-page pamphlet of its self-propelling car for shifting track for dump cars making railway fills or waste dumps at mines, quarries and steel plants. On railway maintenance work the machine can shift tracks in yards and can line main tracks or raise them for ballasting, while with a portable boom attached it serves to handle rails, ties and other material.

Pneumatic Conveying Systems—B. F. STURTEVANT CO., INC., Boston, Mass., devotes its catalog No. 291 to "Pneumatic Collecting and Conveying Systems," in which is discussed the apparatus used in a large number of factories which have dust and waste to dispose of. The second half of the book covers design and application of the collecting systems, pipe areas, tables for friction losses, methods of determining size of fans and pipes, and other information of interest and value to engineers and architects concerned with such installations.

Engineering News-Record Statistics of the Construction Industry

April 7, 1927 *in the United States* Vol.98, No.14



Engineering News-Record CONSTRUCTION COST Index Number (1913 = 100)

MONTHLY
January, 1926 to Date

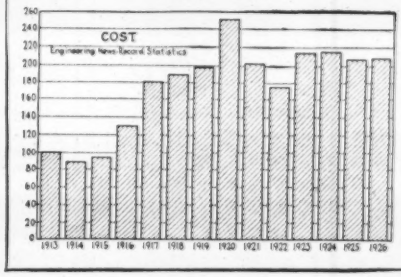
April, 1927	**209.00**
March, 1927	208.80
April, 1926	207.05
Peak, June, 1920	273.80
1913	100.00

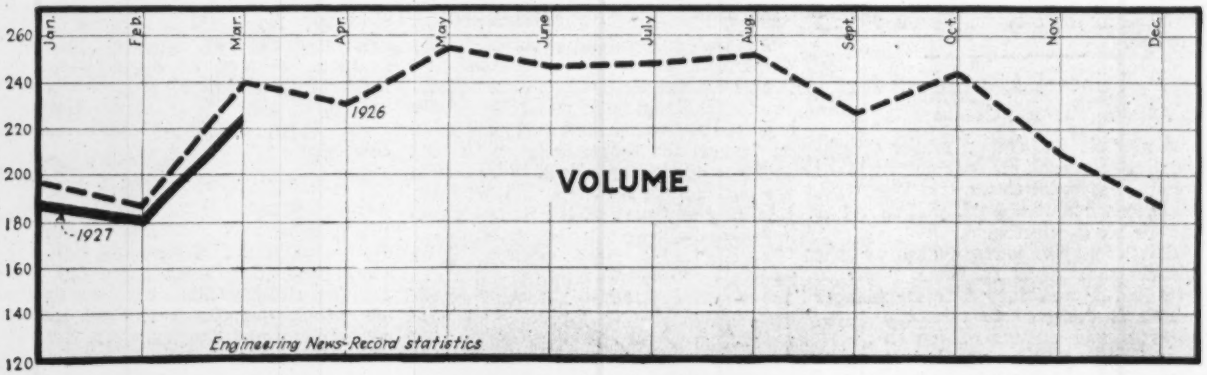
1926

Jan.	207.15	May	207.30
Feb.	206.55	June	204.80
Mar.	207.65	July	207.80
April	207.05	Aug.	208.30
January, 1927	211.50	February, 1927	210.15
Sept.	208.30
Oct.	209.80
Nov.	210.80
Dec.	210.80

Engineering News-Record's Construction Cost Index Number is 0.09 per cent above March, 1927. The very slight increase is due mainly to wage rate adjustments. The average rate for common laborers is now 56c. per hr., against 54¼c. at this time last year. Thus, general construction cost is 0.9 per cent above April, 1926, 24 per cent under the peak and 109 per cent above 1913.

YEARLY
1913 to 1926





Engineering News-Record CONSTRUCTION Volume Index Number (1913 = 100)

MONTHLY
January, 1926 to March, 1927

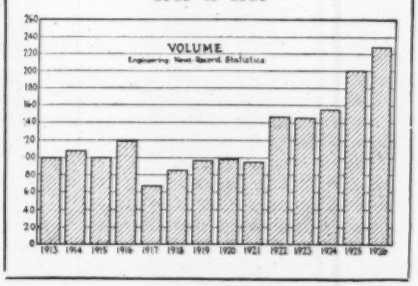
March, 1927	**226**
February, 1927	182
March, 1926	240
Peak, August, 1925	266
1913	100

1926

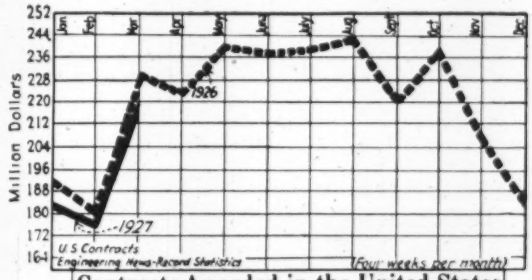
Jan.	198	May	254
Feb.	187	June	246
Mar.	240	July	248
April	233	Aug.	252
January, 1927	187		
Sept.	227
Oct.	244
Nov.	211
Dec.	188

Engineering News-Record's Construction Volume Index Number is 226 for the month of March and 228 for the whole of 1926, as against 100 for 1913. This means that the actual volume of contract letting in 1926 (not the mere money-value of the contracts let that year) is 128 per cent above the volume for 1913. The monthly volume number, 226 for March, 1927, contains the increment of construction and indicates the rate at which contracts are being let as compared with 1913 awards.

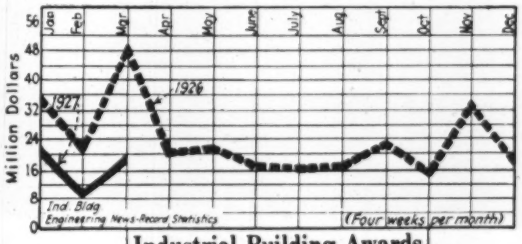
YEARLY
1913 to 1926



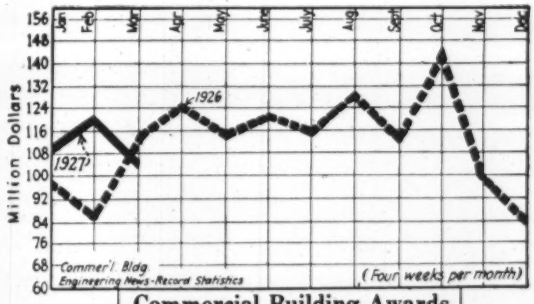
Monthly Statistics of the Construction Industry



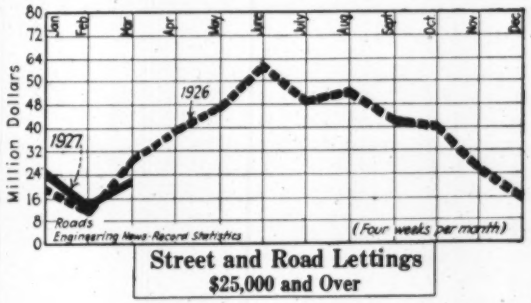
Contracts Awarded in the United States
Reported by E. N.-R.



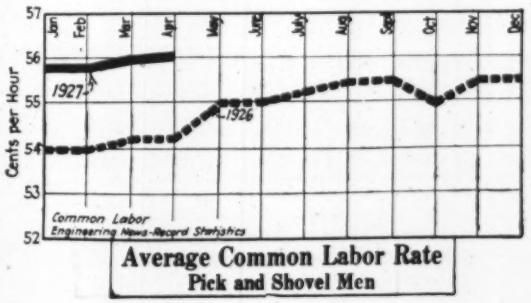
Industrial Building Awards
$40,000 and Over



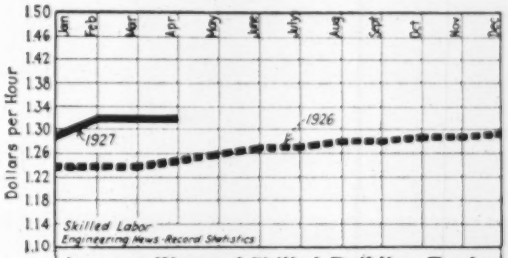
Commercial Building Awards
$150,000 and Over



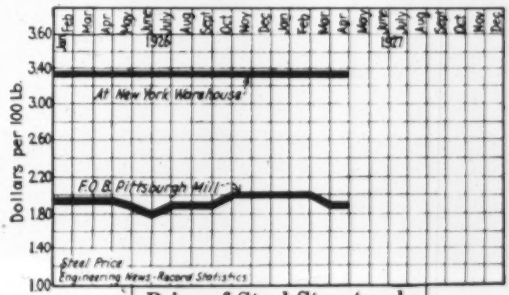
Street and Road Lettings
$25,000 and Over



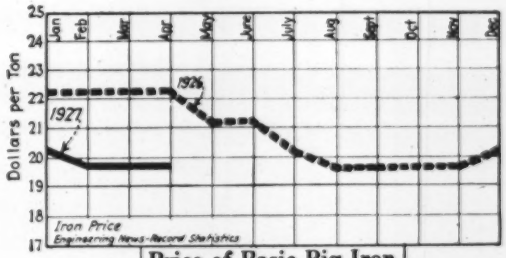
Average Common Labor Rate
Pick and Shovel Men



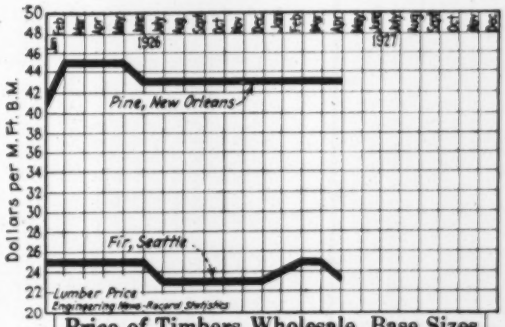
Average Wage of Skilled Building Trades
Bricklayers, Carpenters and Steel Erectors



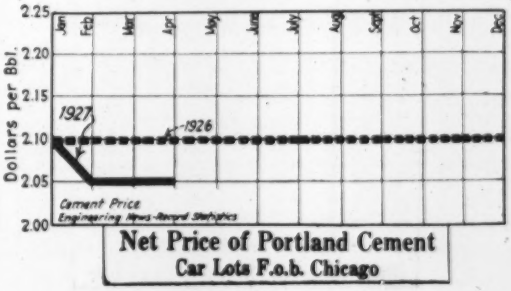
Price of Steel Structurals
Shapes 3-in; Plates ¼-in.



Price of Basic Pig Iron
F.o.b. Pittsburgh

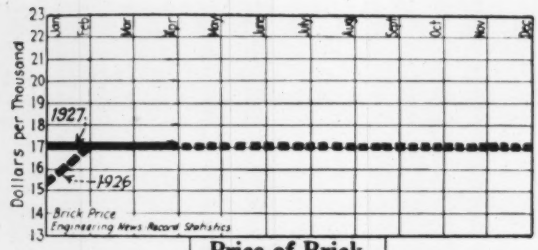


Price of Timbers, Wholesale, Base Sizes
Car Lots to Contractors

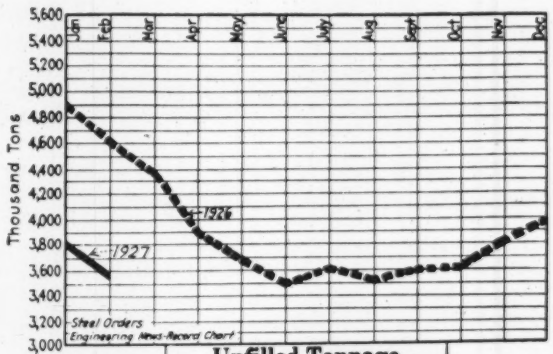


Net Price of Portland Cement
Car Lots F.o.b. Chicago

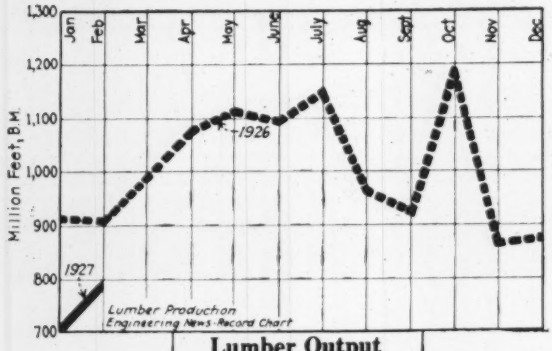
Monthly Statistics of the Construction Industry



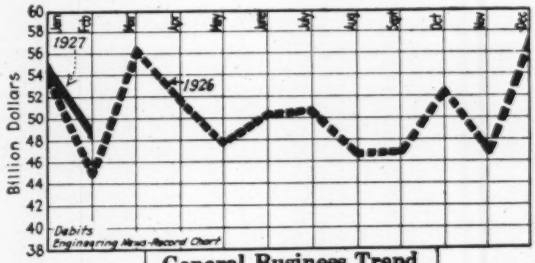
Price of Brick
At Dock, New York



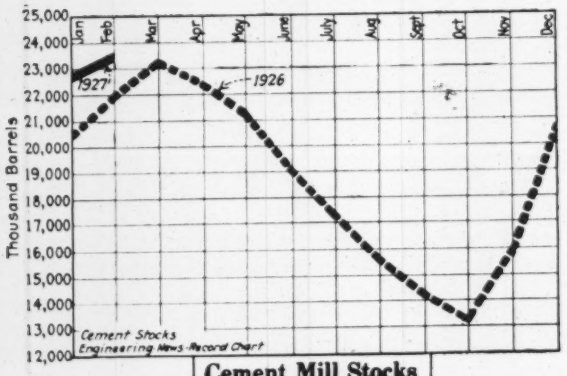
Unfilled Tonnage
On Books of U. S. Steel Corp.



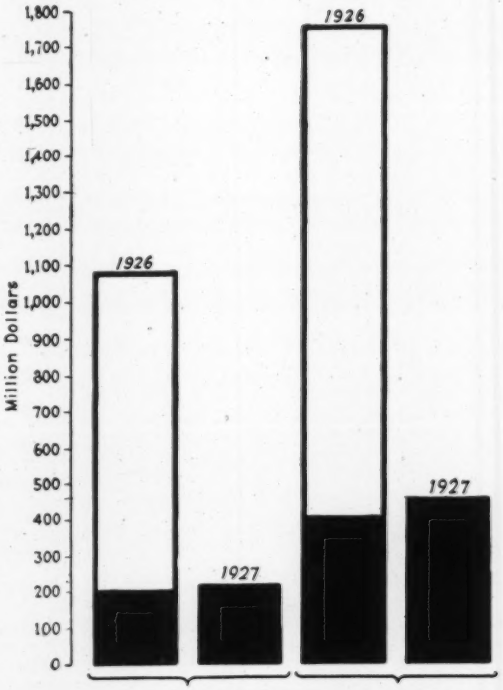
Lumber Output
Nat. Lumber Mfrs. Assn.



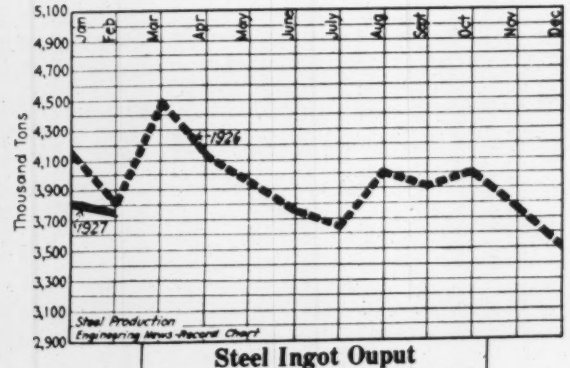
General Business Trend
Bank Debits—Federal Reserve



Cement Mill Stocks
Bureau of Mines



Public—Contracts—Private
Jan. 1 to date
Reported by E. N.-R.



Steel Ingot Ouput
Gross Tons; Am. Iron and Steel Inst.

States to Build 26,841 Miles of Roads in 1927

Will Construct Several Large Bridges and Maintain 239,847 Miles of Highway

THE construction of 26,841 mi. of road and maintenance of 239,847 mi. are included in the 1927 State highway programs of forty-seven states, according to reports received by the Bureau of Public Roads, United States Department of Agriculture. The programs also include the construction of a number of large bridges and the reconstruction of roads previously improved. On account of uncertainty of supporting legislation no estimate of the season's work is possible as yet in the state of Connecticut.

In carrying out the above programs it is expected there will be expended under the supervision of the State highway departments in the forty-seven states, a total of $648,483,000.

In addition to the state expenditures approximate estimates indicate that counties and other lesser sub-divisions of government will expend during the year $475,000,000.

Of the expenditures by the state highway departments of the forty-seven states, approximately $421,000,000 is the estimated amount for road construction and, according to present plans, more than $56,000,000 additional will be spent for new bridges. For reconstruction of existing roads it is estimated that the expenditure will come close to $27,000,000, and for maintenance approximately $126,000,000.

The mileage of new state highway construction contemplated during the year, subdivided by classes of surface, is given in the accompanying table.

PROGRAM OF ESTIMATED STATE AND LOCAL HIGHWAY AND BRIDGE EXPENDITURES FOR CALENDAR YEAR—1927
UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF PUBLIC ROADS

States	Grand Total Expenditures (Estimated) On State and Local Roads	Probable Expenditures By State Highway Departments: Total State Road Expenditures	Construction Expenditures: Roads	Construction Expenditures: Bridges	Maintenance (1) Road Upkeep	Probable Expenditures On Roads and Bridges By Local Authorities	Estimated Road Mileage to be Built By State Highway Departments: Total Mileage	Earth Improved	Sand-Clay, Gravel, and Macadam	Asphalt, Concrete, and Brick	Miles of Road Maintained By State Highway Department
Alabama	$20,950,000	$10,950,000	$8,000,000	$1,500,000	$750,000	$10,000,000	406	67	279	60	2,700
Arizona	3,600,000	2,900,000	2,000,000	200,000	700,000	700,000	100	30	67	3	1,620
Arkansas	16,000,000	6,900,000	4,000,000	600,000	2,000,000	9,100,000	580	250	300	30	7,500
California	45,550,000	15,550,000	2,500,000	780,000	5,000,000	27,000,000	80	....	65	15	6,131
Colorado	9,020,000	6,020,000	3,590,000	500,000	1,600,000	3,000,000	124	32	49	43	8,647
Connecticut											
Delaware	2,625,000	2,325,000	1,600,000	400,000	200,000	300,000	75	....	15	60	600
Florida	38,674,800	18,674,800	13,057,320	3,500,000	1,977,480	20,000,000	775	275	100	400	2,104
Georgia	23,600,000	10,100,000	6,900,000	900,000	1,600,000	13,500,000	506	100	250	156	6,300
Idaho	3,280,000	2,780,000	1,200,000	500,000 (3)	1,019,700	500,000	145	25	105	15	2,200
Illinois	68,091,000	41,091,000	33,261,200	3,587,800	2,750,000	27,000,000	1,255	219	....	1,036	5,857
Indiana	39,840,000	14,840,000	9,500,000	1,500,000	3,000,000	25,000,000	415	40	100	275	5,000
Iowa	34,342,000	17,432,000	12,287,000	1,500,000	3,000,000	17,000,000	1,090	308	519	263	6,674
Kansas	33,031,000	21,031,000	15,842,000	2,554,000	2,500,000	12,000,000	1,598	836	522	240	8,690
Kentucky	19,500,000	13,500,000	10,000,000 (5)	.....	3,000,000	6,000,000	900	400	330	170	3,200
Louisiana	19,000,000	11,500,000	6,500,000	2,000,000	3,000,000	7,500,000	500	....	450	50	4,750
Maine	15,151,300	11,251,300	5,720,560 (6)	3,040,740	1,936,000	3,900,000	414	....	359	55	5,000
Maryland	10,400,000	7,500,000	3,000,000	500,000	4,000,000	2,900,000	124	....	35	89	2,500
Massachusetts	30,358,000	16,358,000	7,500,000	250,000	3,000,000	14,000,000	240	....	50	190	(8) 1,565
Michigan	52,750,000	20,750,000	15,000,000	1,600,000	4,150,000	32,000,000	415	50	165	200	7,300
Minnesota	31,700,000	14,500,000	7,860,000	665,000	4,500,000	17,200,000	1,007	490	390	127	(10) 6,956
Mississippi	9,630,000	4,630,000	2,780,000 (5)	.....	1,700,000	5,000,000	524	231	238	55	4,000
Missouri	28,893,825	18,893,825	13,043,825	1,500,000	3,000,000	10,000,000	922	450	350	122	7,640
Montana	8,655,000	3,655,000	2,890,000	250,000	315,000	5,000,000	251	....	250	1	1,100
Nebraska	17,100,000	7,100,000	4,000,000	600,000	2,000,000	10,000,000	1,310	600	700	10	6,000
Nevada	2,360,530	1,860,530	1,330,185	60,000	279,000	500,000	149	....	145	4	1,502
New Hampshire	5,520,000	4,020,000	1,300,000	100,000	1,800,000	1,500,000	100	10	75	15	2,000
New Jersey	35,400,000	19,400,000	11,600,000	3,000,000	2,000,000	16,000,000	120	10	....	110	3,890
New Mexico	3,882,000	3,582,000	1,900,000	510,000	838,000	300,000	179	45	125	9	4,860
New York	85,400,000	61,400,000	51,000,000	3,000,000	7,400,000	24,000,000	1,006	....	....	1,006	9,781
North Carolina	(14) 25,000,000	15,000,000	11,000,000 (5)	.....	4,000,000	10,000,000	650	....	500	150	6,400
North Dakota	4,490,000	1,900,000	960,000	100,000	590,000	2,590,000	1,042	521	521	....	2,746
Ohio	53,000,000	25,000,000	12,000,000	1,000,000	8,000,000	28,000,000	850	50	500	300	9,900
Oklahoma	26,250,000	11,250,000	6,900,000	1,750,000	2,000,000	15,000,000	850	300	400	150	5,500
Oregon	15,000,000	6,750,000	3,000,000	600,000	2,400,000	8,250,000	252	125	125	2	3,000
Pennsylvania	(15) 84,350,000	67,950,000	48,000,000	1,000,000	12,500,000	16,400,000	1,300	100	400	800	12,033
Rhode Island	7,475,000	6,650,000	2,500,000	(17) 3,150,000	825,000	825,000	44	....	....	44	450
South Carolina	23,925,000	12,925,000	9,250,000	1,000,000	2,200,000	11,000,000	600	....	350	250	5,250
South Dakota	10,456,650	3,956,650	2,100,000	244,500	836,800	6,500,000	450	....	450	....	4,669
Tennessee	37,000,000	20,000,000	10,150,000	5,850,000	4,000,000	17,000,000	529	223	113	193	5,000
Texas	31,000,000	22,000,000	11,350,000	2,000,000	7,000,000	9,000,000	1,800	600	1,000	200	19,000
Utah	3,770,000	2,540,000	1,600,000	200,000	600,000	1,230,000	100	....	93	7	3,300
Vermont	(14) 4,500,000	3,750,000	1,500,000	500,000	1,750,000	750,000	110	....	100	10	3,000
Virginia	21,089,950	13,089,950	9,200,000 (5)	.....	3,266,730	8,000,000	225	50	100	75	5,207
Washington	18,620,000	9,250,000	6,250,000	1,000,000	1,250,000	9,370,000	385	170	165	50	3,200
West Virginia	(14) 17,300,000	11,300,000	9,000,000	500,000	1,800,000	6,000,000	425	200	150	75	2,200
Wisconsin	24,772,000	21,462,000	15,262,000	2,000,000	3,000,000	3,310,000	1,569	....	1,195	374	(18) 10,000
Wyoming	4,214,000	3,215,000	1,700,000	480,000	666,000	999,000	350	150	200	....	2,925
Totals (except Conn.)	1,123,607,055	648,483,055	420,884,090	56,472,040	125,699,710	475,124,000	26,841	6,957	12,395	7,489	239,847

Remarks: The above data is reported by the State Highway Departments of the respective states with but few exceptions as noted. The figures which are conservative estimates as a rule, represent preliminary budgets, except that road bond payments which amount to over $100,000,000 are excluded.

(1) Some states include reconstruction of road costs in maintenance expenses and when so reported are shown here separately. In other states reconstruction is included with construction, the allocation depending upon the policy of the state in regard to road construction. (2) Where no entry is shown, overhead is included in construction and maintenance. If large miscellaneous expenses are reported same are noted. (3) Includes 300 miles of road oiling, $360,000. (4) Represents road building through cities and refunds; overhead included in construction and maintenance. (5) Included in road construction. (6) Includes Kennebec Bridge, $2,090,740. (7) Includes $464,000 for other than overhead. (8) State highway mileage thoroughly maintained: excludes 6,000 miles of town roads partly maintained. (9) Includes $500,000 for purchase of right of way. (10) Excludes local road mileage formerly reported maintained by State Highway Department. (11) Includes $650,000 for miscellaneous expenses. (12) Miscellaneous only. (13) Includes $1,500,000 for purchase of right of way. (14) Estimate (based on previous year's data) made by Bureau of Public Roads. (15) Partial estimate by Bureau of Public Roads. (16) Excludes $2,300,000 expenses for Highway Patrol and Motor Vehicle Registration Bureau. (17) Includes $3,000,000 bond issue for Washington Bridge at Providence. (18) In addition state maintains 12,200 miles of local system.

Value of Contracts Let in the United States and Canada During March, 1927

FIGURES in the accompanying table are for the nation as a whole and are based on a minimum value for each class of work, as follows: water-works, excavations, drainage, irrigation, levee, river and harbor projects, $15,000; other public work, $25,000; industrial buildings, $40,000; commercial, educational, and other buildings, $150,000.

The geographic divisions mentioned in the accompanying tabulation comprise the following states: *New England*—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut. *Middle Atlantic*—New York, New Jersey, Pennsylvania, Delaware, Maryland, District of Columbia. *South*—Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Tennessee, Kentucky. *Middle*

West—Ohio, Indiana, Michigan, Illinois, Wisconsin. *West of the Mississippi*—Iowa, Minnesota, Kansas, Nebraska, South Dakota, North Dakota, Wyoming, Montana, Missouri, Arkansas, Texas, Oklahoma, Colorado, New Mexico. *Far West*—Idaho, Utah, Nevada, Arizona, Washington, Oregon, California.

CONTRACTS AWARDED BY CLASSES FOR MARCH, 1927

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Jan 1 to Date U. S.	Canada
Water-works	$167,000	$1,008,000	$2,197,000	$3,081,000	$922,000	$2,075,000	$9,450,000	**$16,807,000**	$457,000
Sewers	60,000	3,117,000	180,000	3,332,000	1,558,000	705,000	8,952,000	**20,002,000**	319,000
Bridges	25 000	948,000	361,000	298,000	997,000	605,000	3,234,000	**13,020,000**	200,000
Excavation, drainage, irrigation		414,000	861,000	54,000	4,748,000	835,000	6,912,000	**8,459,000**	25,000
Streets and roads	112,000	6,002,000	4,875,000	7,947,000	6,156,000	4,073,000	29,165,000	**65,783,000**	
Industrial buildings	6,600,000	5,624,000	1,795,000	3,440,000	4,107,000	2,907,000	24,473,000	**55,604,000**	1,050,000
Commercial buildings	13,371,000	41,687,000	1,965,000	6,526,000	21,447,000	17,913,000	130,909,000	**362,614,000**	2,175,000
Federal government	1,531,000	2 381 000	124 000	84 000	191,000	576,000	4,887,000	**10,464,000**	
Unclassified	118 000	23,075,000	4,411,000	4,182,000	23,178,000	492,000	55,456,000	**77,695,000**	1,083,000
March, 1927	$21,984,000	$84,256,000	$16 769,000	$56,944,000	$63,304,000	$30,181,000	$273,438,000	**$630,448,000**	$5,309,000
February, 1927	9,937,000	42,439,000	21,008,000	45,832,000	30,123,000	25,931,000	175,270,000		3,594,000
March, 1926	11,983,000	99,556,000	25,140,000	46,524,000	24,565,000	22,552,000	230 320,000		10,818 000
Jan. 1 to date, 1927	**50,446,900**	**178,076,000**	**50,493,000**	**142,880,000**	**117,868,000**	**90,685,000**	**630,448,000**		**13,931,000**
Jan. 1 to date, 1926	28,812,000	233,970,000	82,448,000	124,883,000	70,639,000	60,247,000	600,999,000		22,954,000

Labor Rates and Conditions Throughout the Country

High Wage Levels Maintained

A SUFFICIENTLY large volume of construction work is already under contract, to provide practically full employment for the nation's building trades operatives, during the current quarter. The present tendency is strongly in the direction of settlement at 1926 wage rates and conditions, in the construction industry.

The following table shows the few minor wage adjustments that occurred during the last month. Important strikes are in operation in not more than three out of twenty-seven cities reporting.

Current Building Trades Wage Rates Per Hour

(Higher rates than a month ago indicated by +, decreases by—)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1 40	$0.70	$0 70	$0.50	.....	$0 75	$0.25@.30
Baltimore	1 62½@1 75	1 00@1 10	1 00@1 12½	1 00	$0 65	1.12½	.40
Birmingham	1 00@1 50	.40@1 05	.75@1 00	50@ 75	.....	.75@1 75	—.20@ 40
Boston	1 40	1 25	1 25	.79	1 15	1 25	.45@ 74
Cincinnati	1 50	1 31¼	1 31¼	95	1 31¼	1 31¼	.45@.58
Chicago	1 62½	1.10@1.50	1 00@1 50	.90@.96¼	1 50	1 50	.90
Cleveland	1 50	1 25	1 30	.87½@1.10	1.10	1 50	.87½
Dallas	1 62½	1 12½	1 00	.40@.75	1 00	1 00	.30@ 50
Denver	1 62½	1 25	1.12½@1 18¾	.81¼@.87½	1 00	1.15⅝	.40@ 55
Detroit	1 50	.90@1 15	.85@1.00	.90	.85@1 00	1 12½	— 40@ 60
Kansas City, Mo	1 50	1 25	1.25	.90	1.25	+1.37½	.40@.75
Los Angeles	1.37½	1 00	1.00	.87½	.87½	1.00	.50
Minneapolis	1.25	.87½@95	.87½	.75	....	1 00	.45@ 60
Montreal	1 00	.75	.60	.40	.50	.75	+ 25@ 30
New Orleans	1 50	.90	1 00	.75	.80	1 25	.30@ 40
New York	1.75	1.50	1.75	1.12½	1.00@1.12½	1.75	.90⅝
Philadelphia	1.50@1.62½	1.12½@1.25	1.02½	1.12½	1.00	1.12½@1.25	.45@.50
Pittsburgh	1 62½	1.50	1.37½@1.50	1.12½	....	1.50	.80
St. Louis	1 75	1 50	1 50@1 65	1.15@1 25	1 25	1 50	—.40@.75
San Francisco	1 37½	1 12½	1 00@1 06¼	.87½	1 12½	1 37½	.50@.60
Seattle	1 37½	1.12½	1.00@1.12½	1.00	1.00@1.12½	1.12½	.62½

Monthly Prices of Construction Materials

Declines Predominate

DEMAND for materials as indicated by volume of construction contract letting is approximately 5 per cent under a year ago, while advance in costs, due mostly to labor, represents a small fraction of one per cent, compared with April, 1926.

The effect of the present fine adjustment of cement production to demand is to lessen possibilities of price fluctuation in either direction.

Reported cutting under in mill prices of structural steel shapes and plates exerts but little influence in the current market and does not affect accompanying price tables.

Lumber cutting and selling in both hard-wood and soft-wood descriptions hold up well from week to week, with the advantage slightly in favor of the former. Pine price advances are in excess of declines, comparing this month with last; while in Douglas fir the opposite condition obtains. Hemlock and spruce show little tendency to fluctuate. More than half of the price changes in the April tabulation were in the West, where declines seem to predominate. New England prices remain firm, while those in the Middle Atlantic section show no particular tendency to develop strength.

Brick demand is increasing in volume as the season advances, with supply well abreast of consumption. Offsetting declines in New York and San Francisco, due to keen competition for contracts, price advances cropped out this month at Boston, Montreal, Detroit, Pittsburgh and Cleveland.

Cast-iron pipe went up $1 per ton at the principal distributing centers, marking the opening of spring waterworks activities. Advances, effective during the first week in April, also occurred in boiler rivets, curbing, blue-annealed steel sheets, and sewer pipe. Declines affected principally the following: pig iron, asphalt, structural rivets, window glass, black and galvanized steel sheets, linseed oil, and steel sheet-piling. Concrete blocks advanced 1c. apiece at Minneapolis and 2c. in Pittsburgh, compared with March levels; quotations in other cities held firmly, despite uncertainty of the cinder ash market due to the coal strike.

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton f.o.b.:

	April 7	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25@2.75)	$22.19	$24.05
Northern Basic	20.89	24.27
No. 2 Southern Ohio (silicon 1.75@2.25)	*21.19*	24.27
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25@2.75)	26.37	28.37
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@2.75)	18.50	22.00
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	*22.76*	24.16
Virginia No. 2 (silicon 2.25@2.75)	*22.17*	29.17
Basic	21.76	23.16
CHICAGO		
No. 2 Foundry Local (silicon 1.75@2.25)	21.00	23.00
No. 2 Foundry Southern (silicon 2.25@2.75)	*23.55*	26.55
PITTSBURGH, including freight charge ($1.76) from the Valley		
No. 2 Foundry Valley (silicon 1.75@2.25)	20.26	22.27
Basic	19.76	22.27
Bessemer	21.26	22.27

SCRAP—The prices following are f.o.b. per net ton paid by dealers:

	New York*	Chicago	Birmingham
No. 1 railroad wrought	$12.50@$13.50	**$12.50@$13.00**	$12.00@$13.00
Stove plate	8.50@ *10.50*	13.50@ 14.00	14.00@ 14.50
No. 1 machinery cast	15.00@ 16.00	16.50@ **17.00**	17.00@ 17.50
Machine shop turnings	*7.50@ 8.00*	**7.00@ 7.50**	8.00@ 8.50
Cast borings	*8.00@ 8.25*	**9.50@ 10.00**	8.00@ 9.00
Railroad malleable	*12.50@ 13.00*	14.00@ 14.50	16.00@ 17.00
Re-rolling rails	*11.50@ 12.00*	**14.25@ 14.75**	15.00@ 16.00
Re-laying rails	23.00@ 24.00		21.00@ 22.00
Heavy melting steel	*8.25@ 11.85*	**11.75@ 12.25**	13.00@ 14.00

*Gross ton.

Railway Supplies

STEEL RAILS—The following quotations are per ton f.o.b. for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh				
	April 7	One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	.....
Standard openhearth rails	43.00	43.00	43.00	43.00	$51.00
Light rails, 8 to 10 lb.	.....	35.00	34@36	1.80@1.90*	2.05-2.15*
Light rails, 12 to 14 lb.	36.00	35.00	34@36	1.80@1.90*	1.88-1.98*
Light rails, 25 to 45 lb.	.....	35.00	34@36	1.80@1.90*	1.84-1.94*
Re-rolled rails	*30@34*	32@33	30.00	34@36	.....

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, white oak, plain	$1.45	$1.83
Chicago, empty cell creosoted	1.85	2.45
Chicago, zinc treated	1.65	2.15
San Francisco, green Douglas fir	.84	1.14
San Francisco, empty cell creosoted, Douglas fir	1.70	2.25
St. Louis, white oak, plain	1.20	1.45
St. Louis, zinc treated	1.60	1.85
St. Louis, red oak, plain	1.10	1.35
St. Louis, sap pine-cypress	.95	1.20
Birmingham, white oak	1.25	1.45

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh mill for carload lots, together with the warehouse prices at the places named:

	Pittsburgh					
	April 7	One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	$2.80@$3.00	$2.80	$3.55	$3.65	*$3.85*	$3.00
Track bolts	3.90@4.50	3.90@ 4.15	4.55	4.60	*5.35*	3.90
Standard section angle bars, splice bars or fish plates	2.75	2.75	3.40	3.75	**3.90**	4.15

Pipe

WROUGHT PIPE—The following percentage discounts are to jobbers for carload lots at Pittsburgh mill:

	Steel Black	Steel Galv.		Iron Black	Iron Galv.
	BUTT WELD				
Inches			Inches		
1 to 3	62	50½	1 to 1½	30	12
	LAP WELD				
2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

	BUTT WELD, EXTRA STRONG, PLAIN ENDS			
1 to 1¼	60	49½	1 to 1½	30	14
2 to 3	61	50½			
	LAP WELD, EXTRA STRONG, PLAIN ENDS			
2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT STEEL PIPE—From warehouses at the places named the following discounts hold for welded steel pipe:

	Black			
	New York	Chicago	Birmingham	St. Louis
1 to 3 in. butt welded	53%	54%	62%	49%
2½ to 6 in. lap welded	48%	51%	59%	46%
	Galvanized			
	New York	Chicago	Birmingham	St. Louis
1 to 3 in. butt welded	39%	41%	50½%	36%
2½ to 6 in. lap welded	35%	38%	47½%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 36—5% off.

CAST-IRON PIPE—The following are prices per net ton for Class B and heavier f. o. b. in car load lots:

			New York	
	Birmingham	Burlington, N. J.	April 7	One Year Ago
4 in.	$42.00	**$50.00**	**$52.60**	$54.60@56.60
6 in. and over	38.00	**46.00**	**48.60**	50.60@52.60
	Pittsburgh	Chicago	St. Louis	San Francisco
4 in.	$49.60	$50.20	$47.60	$51.00
6 in. and over	45.60	46.20	43.60	47.00

Gas pipe and Class "A," $4 per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

	New York					
Size, In.	April 7	One Year Ago	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$48.00	$40.00	$45.00	.....	$73.00
4	55.00	60.00	40.00	56.00	$76.50	110.00
5	.....	.....	.....	80.00	97.75	118.00
6	90.00	90.00	70.00	100.00	127.50	150.00
8	160.00	160.00	170.00	165.00	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	.....	**$0.092**	$0.10	.....	$.088	$0.12	.....
4	.....	**.092**	.10	**$0.10**	.088	.15	$0.15
5	.....	**.1265**	.135	.....	.121	.18	.18
6	$0.24	**.1265**	.21	.14	.121	.21	.21
8	.43	**207**	.315	.225	.198	.30	.325
10	.50	**273**	.45	.315	.315	.42	.476
12	.65	**351**	.54	.405†	.405	.56	.612
15	1.08†	**468**	.75	.675†	.54	.92	1.02
18	1.58†	**65**	.90	.945†	1.08	1.32	1.53
20	1.89†	**78**	1.20	.....	1.20	.....	.....
21	.....	**91**	1.25	1.26†	1.40	.....	.....
22	2.52†	**1 04**	1.35	.....	1.60	.....	1.564
24	2.84†	**1 17**	2.665	1.62†	1.80	2.16	2.04
27	4.65†	**2.60**	2.952	2.45†	2.75	3.00	3.34
30	5.16†	**2.88**	3.96	3.00†	3.75	3.60	4.06
33	6.98†	**4.05**	4.51	3.55†	4.50	.....	4.99
36	8.00†	**4.6125**	5.06	3.95†	5.00	.....	5.42

	3	5	8	12	24	36
Boston	$0.12	$0.175	$0.25	*$0.49*	*$1.85*†	*$3.20*†
Minneapolis	.....	.....	.25	.45	1.50	4.50
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	.14	.....	.35	.63	2.52	.....
Los Angeles	.1675	.186	.2825	.504	1.74	.....
New Orleans	.....	.....	.205	.40	2.27	3.50
Cincinnati	.105	.1575	.245	.4725	1.575	4.715
Atlanta	.10*	.15*	.25	.425	1.625	.....
Montreal	.....	.50	.70	**1.50**‡	**6.00**‡	.....
Detroit	.111	.1665	.259	.4995	1.665†	3.7925†
Baltimore	.111	.166	.259	.499	1.665	4.92
Kansas City, Mo.	.15	.21	.29	.52†	1.90†	3.80†
Philadelphia	*.105*	*.15*	*.245*	*.40*	*1.40*	*3.50*

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡Freight allowed.

Road and Paving Materials

ROAD OILS—Following are prices per gallon in tank cars, 8,000 gal. minimum f.o.b. place named:

		April 7	One Year Ago
New York, 45% asphalt	(at terminal)	$0.0725@$0.075	$0.065 @$0.07
New York, 65% asphalt	(at terminal)	.0675@ .0725	.0675@.0725
New York, binder	(at terminal)	.07 @ .075	.07 @.075
New York, flux	(at terminal)	.07 @ .075	.07 @.075
New York, liquid asphalt	(at terminal)	.07 @ .075	.07 @.075
St. Louis, 40@50% asphalt		*.0538*	.0570
St. Louis, 50@60% asphalt		*.0568*	.0575
Birmingham, 55% asphalt		.0475	0475
Dallas, 45% asphalt		.0495	.0495
Dallas, 50% asphalt		.0455	.0455
Dallas, binder		.061	.061
San Francisco, binder, per ton		12.00*	12.00*

* F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$24.50	.....
Boston (*Mexican*)	23.50	$19.00
Chicago (*Texas*)	28.00	23.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	18.00	12.00
Dallas (*Texas*)	27.10	21.10
Seattle, *"D" grade, California, f.o.b. Richmond*	19.50	13.50
Denver (*California*)	24.00	.....
Minneapolis, *f.o.b. Twin Cities (Stanolind)*	28.10	22.10
St. Louis (*Mexican*)	*26.00*	*23.00*
Baltimore (*Standard Oil*) (*f.o.b. refinery*)	22.50	18.50
Montreal (*Imperial*)	27.00	22.50
Atlanta (*Mexican*)	24.40	19.40
Detroit (*Mexican*)	*24.00*	*19.00*
Cincinnati (*Kentucky Rock*)	.....	11.65
Maurer, N. J. (*Bermudez*)	30.00	.....
Maurer, N. J. (*Trinidad*)	23.00	.....
Philadelphia (*Mexican*)	20.00	18.00
Kansas City, Mo. (*Texas*)	*27.00*	*22.00*
Los Angeles ("*D*" *grade, California*)	**16.00*	**12.00*
Birmingham (*Mexican*)	27.00	21.00
New Orleans (*Mexican*)	20.00	17.00

* F.o.b. El Segundo Refinery. Drums used in New York.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade I)	5-in. granite,	30 blocks per sq.yd.	$130.00 per M.
San Francisco		Basalt block 4x7x8	70.00 per M.
Chicago		about 5x8x5 dressed	3.60 per sq.yd
		about 5x8x5 common	3.25 per sq.yd.
Boston		5-in. Granite	*132.50* per M.
Atlanta		Granite	2.50 per sq.yd.
Detroit		5-in. Granite	3.00 per sq.yd.
Baltimore		Granite	2.85 per sq.yd.
Montreal		Granite	104.75 per M.
New Orleans		Granite, 4x8x4	2.75 per sq.yd.
Cincinnati		Granite	135.00 per M.
St. Louis		Granite, 4x8x4	1.65 per sq.yd.
Kansas City		Granite	4.00 per sq.yd.
Philadelphia		Granite	3.90@4.25 per sq.yd.
Minneapolis		Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5x16 in., 88c.; *St. Louis*: Class "A" straight, delivered, 5x18 in., $1.05 per lin.ft.; roundings, **$1.80**. *Birmingham*: Limestone, 5x18-in., $1.05 per lin.ft.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	2.40
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	2.45
St. Louis	4	16	2.80
Seattle	4	16	Off market
Minneapolis	3½	16	2.20
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Cincinnati	3½	16	2.35
Kansas City	4	16	2.50
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Price for cargo or carload lots to contractor, *f.o.b.*, per cu.yd., is as follows:

	Gravel 1½ In. Apr. 7	Gravel 1½ In. One Year Ago	Gravel ¾ In. Apr. 7	Gravel ¾ In. One Year Ago	Sand Apr. 7	Sand One Year Ago
New York (*alongside dock*)	$1.75	$1.75	$1.75	$1.75	$1.00	$1.00
Denver	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	*1.80*	1.60	*1.80*	1.60	1.65	1.40
St. Louis	1.45†	1.45†‡	55–1.65†	1.45†	.83‡†	1.08
Seattle	1.25	1.50	1.25	1.50	1.25	1.50
Dallas	2.38*	2.38	2.38*	2.38	2.00*	2.00
Minneapolis	1.65‡	1.65	1.65‡	1.65	1.25	1.25
Cincinnati	1.30†	1.40†	1.30†	1.40†	1.05†	1.35†
San Francisco	1.80	1.80	1.80	1.80	1.40	1.40
Boston (*on trucks at dock*)	1.75†	1.50†	1.75†	1.50†	1.25†	1.00
New Orleans	2.10†*	2.60	3.00†*	2.60	1.80†	1.75
Los Angeles	*1.95†**	1.15†	*1.75†**	1.15†	**1.70†**	.90‡†
Atlanta	1.90†	1.90†	1.90†	1.90†	1.60†	1.50†
Detroit	1.70	2.17	1.60	2.17	1.35	1.48
Baltimore	1.40	1.40	1.60	1.60	.70‡	.70‡†
Montreal	**1.90†**	1.25†	1.50†	1.25†	**1.35†**	1.25†
Birmingham	2.00*	2.00	2.00*	2.00	1.50	1.50
Philadelphia	2.25*	2.10	2.25*	2.10	1.65	1.50
Kansas City, Mo.	.....	.....	.....	.....	.66‡†	.66‡†
Pittsburgh	.85‡	.....	.85‡	.....	.....	.....

*Delivered. † Per ton. ‡ At pit.

CRUSHED STONE—Price for cargo or carload lots, per cu.yd. f.o.b. city, as follows:

	1½ In. Apr. 7	1½ In. One Year Ago	¾ In. Apr. 7	¾ In. One Year Ago
New York	$1.84	$1.75	$1.94	$1.85
Chicago	1.70	1.75	1.87½	1.87½
St. Louis	1.93*	1.93*	1.93*	1.93*
Dallas	2.40†	2.40	2.83†	2.83
San Francisco	1.70	1.70	1.70	1.70
Boston (*on trucks at dock*)	2.10*	1.60*	2.10*	1.60*
Minneapolis	1.75	1.75	1.75	1.75
Kansas City, Mo. *f. o. b. crusher*	2.00	1.50	2.00	1.50
Denver	2.50†	2.50	2.50†	2.50
Seattle	3.00†	3.00	3.00†	3.00
Atlanta	2.50*†	2.50*	2.50*†	2.50*
Cincinnati	1.65*	1.90*	1.65*	1.90*
Los Angeles	**2.20*†**	1.40*	**2.20*†**	1.40*
Detroit	2.60*†	2.00*	2.60*†	2.00*
Baltimore	2.50†	2.50	2.55†	2.55
Montreal	1.80*	1.80*	2.00*†	1.50
Philadelphia	2.25†	2.10	2.25†	2.10
Pittsburgh	2.75†	2.85	2.75†	2.85
Cleveland	2.70*†	3.25*	2.70*†	3.25*
Birmingham	2.00†	2.00	2.00†	2.00

* Per ton. † Delivered.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plant

	1½-In	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Buffalo District	1.25	1.35	2.25	1.25
Birmingham, Ala	.90	1.25	2.05	.80
Cleveland, Ohio	1.70*	1.70*	.....	1.40*
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25

*Includes freight charge.

LIME—Warehouse prices:

	Hydrated, per Ton— Finishing	Hydrated, per Ton— Common	Lump, per Barrel— Finishing	Lump, per Barrel— Common
New York	$18.20	$11.00	$3.50*	$2.10@3.00*
Chicago	20.00	18.00	.....	1.50†
St. Louis	23.50	17.50	.....	2.03*
Boston	*18.25*	*11.00*	*3.50**	*2.15@3.00**
Dallas	19.00	.....	.....	1.82†
Cincinnati	16.80	11.90	.....	11.40‡
San Francisco	**27.50**	**24.00**	.....	**1.70†**
Minneapolis	25.50	21.00	.....	1.70†
Denver	24.00	.....	.....	2.70*
Detroit	15.25	11.25	.....	11.75‡
Seattle, *paper sacks*	24.00	.....	2.80†	.....
Los Angeles	25.00	15.00	**3.50***	**19.00‡**
Baltimore	24.25	17.85	2.55†	.....
Montreal	.....	21.00	.....	10.00‡
Atlanta	**22.50**	13.00	.....	**1.50†**
New Orleans	24.00	15.00	2.60†	2.25*
Philadelphia	23.00	16.00	.....	.....
Kansas City	18.50	17.50	**2.50†**	2.25*
Birmingham	22.50	16.00	2.40†	1.85†

* Per 280-lb. bbl. (net). † Per 180-lb. (net). ‡ Per ton.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, exclusive of bags:

	Apr. 7	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.45	2.20
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	2.75	2.65
St. Louis (Carney)	2.35	2.35
Birmingham (Magnolia) pozzolan cement	2.40	2.40

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Apr. 7	One Month Ago	One Year Ago
New York, del. by truck	$2.35@$2.50	$2.35@$2.50	$2.50
New York, alongside dock to dealers	2.03	2.03	2.15
Jersey City	2.28	2.28	2.33
Boston	*2.25*	2.35	2.40
Chicago	2.05	2.05	2.10
Pittsburgh	2.04	2.04	2.09
Cleveland	2.24	2.24	2.29
Detroit	2.15	2.15	2.15
Indianapolis	2.19	2.19	2.29
Milwaukee	2.20	2.20	2.25
Duluth	2.04	2.04	2.09
Peoria	2.22	2.22	2.27
Cedar Rapids	2.24	2.24	2.34
Davenport	2.24	2.24	2.29
St. Louis	2.05	2.05	2.20
San Francisco	**2.51**	2.31	2.31
New Orleans	2.40	2.40	2.40
Minneapolis	2.22	2.22	2.32
Denver	2.85	2.85	2.84
Seattle	2.65	2.65	2.65
Dallas	2.05	2.05	2.05
Atlanta	2.35	2.35	2.35
Cincinnati	2.32	2.32	2.37
Los Angeles	2.50	2.50	2.52
Baltimore	2.50	2.50	2.50
Birmingham	2.40	2.40	2.40
Kansas City, Mo	**2.20**	2.05	2.35
Montreal	1.15	1.15	1.80
Philadelphia	2.50	2.50	2.41
St. Paul	2.22	2.22	2.32
Toledo	2.20	2.20	2.20

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind.	$1.80	Hudson, N. Y.	$1.75
Universal, Pa.	1.80	Leeds, Ala.	1.85
Steelton, Minn	1.85	Hannibal, Mo.	*1.90*
Fordwick, Va.	2.05	Lehigh Valley District	1.75
Mitchell, Ind.	1.90	Wyandotte, Mich.	1.90
Iola, Kan.	1.85	Alpena, Mich.	1.75
Mason City, Ia.	1.80	Kingsport, Tenn.	**2.05**
La Salle, Ill.	1.90		

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carload lots at mills; from warehouse in less-than-carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0.99	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.26	1.29	1.76	1.35	1.38	1.55
068	35	1.54	1.58	2.16	1.66	1.67	1.91
093	45	1.98	2.03	2.77	2.13	2.00	2.46
126	57	2.45	2.51	3.45	2.63	2.55	3.03
153	68	2.92	2.99	4.11	3.14	3.15	.....
180	78	3.35	3.43	5.70	3.60	3.47	.....
245	103	4.43	4.53	6.21	4.75	4.58	.....
287	119	5.12	5.24	7.19	5.50	5.26	6.35
336	138	5.93	6.07	8.35	6.37	6.11	.....
395	160	6.88	7.04	9.65	7.38	7.12	.....
PAVING							
036P	17	$0.76	$0.77	$1.06	$0.81	$0.76	.....
053P	24	1.07	1.09	1.50	1.14	1.07	.....
072P	31	1.35	1.38	1.90	1.45	1.39	.....
097P	40	1.74	1.78	2.45	1.87	1.90	.....
049R	24	1.07	1.09	....	1.14	1.02	.....
067R	31	1.35	1.38	....	1.45	1.39	.....
089R	40	1.74	1.78	....	1.87	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Prices in less-than-carload lots per 100 yd. for painted:

Weight in pounds	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$17.50	$19.50	$17.50	$16.50	$19.00	$24.00
2.5	18.50	21.50	18.50	17.50	21.00	26.00
3.0	21.00	24.50	21.00	20.00	24.00	29.00
3.4	22.50	27.50	22.50	21.50	26.00	31.00

BARS, CONCRETE REINFORCING—Current quotations per 100 lb., in carload lots, f.o.b., except at New York and St. Louis warehouses:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham Mill	Warehouse: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$1.90	$2.25	$3.24	$2.30@$2.50	$3.15	$2.75	$2.95
⅝	2.00	2.35	3.34	2.40@ 2.60	3.25	2.85	3.05
¾	2.10	2.45	3.44	2.50@ 2.70	3.35	2.95	3.15
⅞	2.30	2.65	3.64	2.70@ 2.90	3.55	3.10	3.35
1	2.90	3.25	4.24	3.30@ 3.50	4.15	3.75	3.95

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923.

ROLLED FROM RAILS

	St. Louis	Dallas		St. Louis	Dallas
½ in and larger	$2.35	$2.48	½	$2.75	$2.88
⅝	2.45	2.58	¾	3.35	3.48
¾	2.55	2.68		....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Apr. 7	Common: One Month Ago	Common: One Year Ago	Paving Block: 3-inch*	Paving Block: 3½-inch*
New York (del.)	$19.00–20.00	$20.40–22.40	$20.40	$45.00†	$51.00†
New York (at dock)	17.00	17.00	17.00		
Chicago	12.00	12.00	12.00	42.00	45.00
St. Louis, salmon (del.)	15.00	15.00	16.00	40.00	42.50
Denver, salmon	9@10	9@10	12.00	.....	.....
Dallas	14.10	14.10	11.10	35.00	.....
San Francisco	14.00	15.00	15.00	.....	.....
Los Angeles	10.50	10.50	11.50	(not used)	
Boston (del.)	20.00	19.50	18.00	45.00	50.00
Minneapolis (del.)	13.75	13.75	14.25	.....	.....
Kansas City	13.50	13.50	15.50	(no market)	
Seattle	15.00	15.00	15.00	.....	55.00
Cincinnati	15.50	15.50	17.00	40.00	45.00
Montreal	21.25	20.25	20.25	100.00‡	
Detroit (del.)	16.15	16.00	16.00	38.40	41.50
Baltimore	18.00	18.00	18.00	40.00	45.00
Atlanta	12.00	12.00	10.50	40.00	.....
New Orleans	15.00	15.00	15.00	60.00	75.00
Birmingham	14.50	14.50	12.50	40.00	45.00
Philadelphia	18.00	18.00	17@21	40.00	50.00
Pittsburgh (del.)	17.00	16.00	16.00	.....	.....
Cleveland	14@16	12@14	14.00	.....	.....

*For paving blocks 3x8½x4 and 3½x8½x4 respectively. †In cars. ‡Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Apr. 7 on Trucks*†	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco†	Perth Amboy N. J., Factory*
4x12x12	$0.1112	$0.1112	$0.076	$0.10	$0.068	$0.108	.....
6x12x12	.1667	.1667	.104	.....	.09	.156	.....
8x12x12	.2084	.2084	.142	.20	.126	.244	.....
10x12x12	.....	.....	.182	.....	.158	.....	$0.252
12x12x12	.....	.....	.202	.....	.188	.....	.312

*5 per cent off for cash. †Partition tile.

	4x12x12	8x12x12	12x12x12
Boston	$0.08	$0.16	$0.26
Minneapolis (f.o.b. cars)	.072	.125	.225
Cincinnati	.064	.1295	.1726
Kansas City	.088	.154	.252
Denver	.085	.155	.22
Seattle	.09	.18	.26
Los Angeles	.085	.172	.285
New Orleans	.11	.205	.31
Detroit	.0707	.1326	.1853
Montreal	.10	....	.....
Baltimore	.124	.268	.....
Atlanta	.0895	.1837	.....
Dallas	.112	.19	.31
Birmingham	.11	.124	.255
Pittsburgh	.068	.128	.179
Cleveland	.07	.12	.....

STRUCTURAL MATERIAL—Following are base prices per 100 lb in carload lots, f.o.b. mill, Pittsburgh and Birmingham, together with quotations in less-than-carload lots from warehouses at places named:

	Pittsburgh Mill	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.90	$2.05	$3.34	$4.15	$3.25	$3.10	$3.00
Channels, 3 to 15 in.	1.90	2.10	3.34	4.15	3.25	3.10	3.00
Angles, 3 to 16 in., ¼ in. thick	1.90	2.10	3.34	4.15	3.25	3.10	3.00
Tees, 3 in. and larger	1.90	2.10	3.34	4.15	3.35	3.10	3.00
Plates, ¼ in. thick and heavier	1.80@1.90	2.00	3.34	4.15	3.25	3.10	3.00

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh Mill	Warehouse: New York Apr. 7	Warehouse: New York One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in.	$2.30@$2.45	$4.20	$4.50	$3.50	$3.65	$5.00	$4.75
CONE HEAD BOILER							
½ in.	$3.00	$4.40	$4.70	$3.70	$3.85	$5.20	$5.00
⅝ and ¾	3.15	4.55	4.85	3.80	4.20@4.45	5.35	5.15
⅞ and 1	3.40	4.80	5.10	4.05	4.60	5.60	5.50

NAILS—The following quotations are per 100 lb. keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.55	$2.85	$2.95	$3.45	$4.25	$2.85	$4.95
Cut	2.80	2.90	....	5.00	5.00	3.00	5.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco: Galv.	San Francisco: Black	Seattle Black
½	$7.50	$5.75	$7.75
⅝	7.05	5.30	5.65
¾	6.90	5.15	5.50

Pittsburgh base in lots of 200 kegs or more, $3.25.

PREPARED ROOFINGS—Slate-surfaced roofing (4 ply) in rolls of 108 sq.ft costs $2.46 per roll to contractors in carload lots f.o.b. New York.

Single shingles, slate finish, cost $6.36 per square (sufficient to cover 100 sq.ft.) in carload lots, f.o.b. New York. Strip shingles (4 in 1) f.o.b. New York, in carload lots to contractors, $5.00 per square.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton	$72.00
Asphalt coating, per gal	.33
Asphalt felt, per 100 lb	3.71

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 83 per cent; "A," 88 per cent; "B," 89 per cent. Double thickness "AA," 83 per cent; "A," 88 per cent; "B," 89 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.15@2.25	$3.60	$3.50	$3.75	$3.89
No. 12	2.20@2.30	3.65	3.55	3.80	3.94
No. 14	2.25@2.35	3.70	3.60	3.85	3.99
No. 16	2.35@2.45	3.80	3.70	3.95	4.09
Black					
Nos. 18 to 20	$2.60@2.70	4.25	3.75	4.50	4.00
No. 22	2.75@2.85	4.40	3.90	4.65	4.15
No. 24	2.80@2.90	4.45	3.95	4.70	4.20
No. 26	2.90@3.00	4.55	4.05	4.80	4.30
No. 28	3.05@3.15	4.70	4.20	4.90	4.45
Galvanized					
No. 10	$2.95@3.05	4.55	4.10	4.55	4.25
Nos. 12 to 14	3.05@3.15	4.65	4.20	4.65	4.35
No. 16	3.15@3.25	4.75	4.30	4.75	4.45
No. 18	3.30@3.40	4.90	4.45	4.90	4.60
No. 20	3.45@3.55	5.05	4.60	5.05	4.75
No. 22	3.50@3.60	5.10	4.65	5.10	4.80
No. 24	3.65@3.75	5.25	4.80	5.25	4.95
No. 26	3.90@4.00	5.50	5.05	5.50	5.20
No. 28	4.15@4.25	5.75	5.30	5.75	5.45

For galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per 7½-lb. gallon for raw oil:

	New York: Apr. 7	New York: One Year Ago	Chicago: Mar. 3	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	$0.83½	$0.83½	$0.83	$0.85

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Apr. 7	1 Yr. Ago	Apr. 7	1 Yr. Ago
Red	$15.25	$15.25	$16.75	$16.75
White	15.25	15.25	15.25	15.25

Lumber

Prices wholesale, per M. ft. b.m., to contractors in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to contractors at yards.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$26.00	$27.00	$28.00	$31.00
3x6 and 8	26.00	27.00	28.00	31.00
4x4-6 and 8	26.00	27.00	28.00	31.00
3x10 and 12	26.00	27.00	28.00	31.00
3x14	30.00	30.00	32.00	34.00
4x10 and 12	26.00	27.00	28.00	31.00
4x14	30.00	30.00	32.00	34.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$28.00	$30.00	$32.00
6x14	34.00	36.00	38.00
8x10	28.00	30.00	32.00
8x14	34.00	36.00	38.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York		Chicago	
	20 Ft. and Under L.L.Y.P.	22-24 Ft. L.L.Y.P.	20 Ft. and Under No. 1 L.L.Y.P.	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$42.00@$44.00	$43.00@$45.00	$38.50	$40.50
3x10 to 10x10	49.00@ 51.00	50.00@ 52.00	45.00	40.50
3x12 to 12x12	56.00@ 58.00	57.00@ 59.00	56.00	40.50
3x14 to 14x14	64.00@ 66.00	65.00@ 67.00	.....	40.50
3x16 to 16x16	76.00@ 78.00	77.00@ 79.00	.....	42.00

New York—Wholesale price of long-leaf yellow pine timbers (rough) to dealers; to contractors, delivered from lighters or cars to job, $5@$10 additional. Short-leaf pine costs $3 per M. ft. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. and $1 for each additional foot from 32 to 36 ft.

Other Cities

	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	$48.50	**$48.25**†	$50.00	$52.00	$58.50	**$58.25**†
Seattle	.....	24.00	.....	.....	.....	*23.00*
New Orleans	36.00	.....	.....	.....	43.00	.....
Baltimore	32.50	49.25	53.00	60.00	38.00	49.75
Cincinnati	37.00	73.00	73.00	85.00	48.00	77.00
Montreal	50.00	55.00	.....	.....	60.00	50.00
Los Angeles	.....	33.00	.....	.....	.....	33.00
Denver	.....	*33.25*	34.25	34.25	.....	33.25
Minneapolis	42.50	*38.75*	34.50	.....	45.00	*38.75*
Atlanta	31.00	.....	.....	.....	34.00	.....
Dallas	56.00	.....	.....	.....	56.00	.....
Kansas City, Mo.	41.50	50.50	.....	.....	55.50	50.50
Birmingham	32.00	.....	.....	.....	34.00	.....
Philadelphia	54.00	*35.00*	38.00	45.00	65.00	*35.00*
Detroit	**48.00**	*44.00*	.....	.....	*58.00*	*42.00*
St. Louis	41.00	.....	.....	.....	53.00	.....

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	$44.00	**$42.50**†	$45.00	$49.00	**$48.50**†
Seattle	.....	22.00	.....	.....	23.50
New Orleans	38.00	46.00	.....	28.00	34.00
Baltimore	55.00	44.00	44.00	34.00	50.00
Cincinnati	70.00	79.00	75.00	38.00	85.00
Montreal	45.00	50.00	40.00	65.00	50.00
Los Angeles	.....	27.00	.....	.....	36.00
Denver	.....	32.25	33.25	.....	**32.75**
Minneapolis	42.50	35.75	34.75	36.00	33.75
Atlanta	22.00	.....	.....	28.00	.....
Dallas	52.25	.....	.....	56.00	.....
Kansas City, Mo.	**50.75**	*45.25*	.....	*32.00*	*37.75*
Birmingham	27.00	.....	.....	45.00	.....
Philadelphia	30.00	*35.00*	36.00	35.00	37.00
Detroit	**40.50**	37.00	.....	46.50	41.25
St. Louis	43.00	.....	.....	29.00	.....

Birmingham—Quotes carload lots, f.o.b. sidings; $4.00 additional per M. ft. to contractors.

Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.

Denver—Quotes dealers price to contractors on large projects.

St. Louis—Wholesale price to contractors, f.o.b. cars, $3 per M.ft. additional.

Seattle—Price to contractors, delivered.

Dallas—Wholesale to contractors, $10 per M.ft. additional.

*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
4 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Apr. 7	One Month Ago	One Year Ago
$2.20@$2.25	$2.25@$2.30	$2.25@$2.30

CONCRETE BLOCKS—Standard 8x8x16-in., delivered to job, each:

Denver	$0.22	St. Louis	$0.20
Detroit	.16	Boston	.20
New Orleans	.25*	Minneapolis	.15*
New York (Brooklyn)	.18@.20	Philadelphia	.18@.20
Pittsburgh	.18		

*F.o.b.

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ⅜-in., 8 ft.; ½-in., 6; ⅝-in., 4½; ¾-in., 3½; 1-in., 2½; 1¼-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following is price per pound for ⅜-in. and larger, in 1200-ft. coils:

Boston	**$0.23**	New Orleans	$0.21
New York	.24½	Los Angeles	.25
Chicago	**.23½**	Seattle	.22
Minneapolis	.25	St. Louis	.24
San Francisco	.22½	Montreal	.17
Atlanta	.27	Detroit	.24½
Denver	.25@.26	Baltimore	.18
Cincinnati	.21	Kansas City	.28
Dallas	.31	Birmingham	.26@.27
Philadelphia	.25		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.265*	$0.2875*
Boston	.24	.26
Kansas City	.2025	.2225
Seattle	.165	.19
Chicago	.195†	.2175†
Minneapolis	.1917	.2123
St. Louis	.22	.245
Denver	.2025	.2275
Dallas	.225	.306
Los Angeles	.1875	.2225
Atlanta	.23	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.1675	.1895
Birmingham	.22	.24
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

*Special gelatin in case lots. †Quantities above 500 lb. and less than a ton

CHEMICALS—Water and sewage treatment chemicals, spot shipments in carload lots, f.o.b. works:

Sulphate of aluminum, in bags, per 100 lb	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb	4.80@4.90
Soda ash, 58%, in bags, per 100 lb	1.32½@1.37½
Chlorine, liquid, tanks, per lb	.04@.04½
Hypochlorite of lime (bleaching powder) in drums, per 100 lb	2.00@2.10

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Atlanta	$0.58	Detroit	**$0.29**
Baltimore	.31	Kansas City	.73½
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.